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I

EOCENE OF LOWER COWLITZ RIVER VALLEY, WASHINGTON

BY

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INTRODUCTION

The purpose of this paper is to place upon record the results of geologic and faunal studies made by the writer during the past three years in portions of the lower Cowlitz River Valley. The area under investigation is of special interest because of the large number of exposures of Eocene strata and the exceptionally well preserved faunas contained within them.

Surface outcrops of Tertiary formations in western Washington are largely obscured because of the heavy overburden of Pleistocene deposits. In King and Pierce counties much detailed work has been done so that the lithology and structure of the Eocene rocks is fairly well known.[1] The strata in this region are, however, almost entirely of estuarine origin, rendering it impossible to make satisfactory correlations with the Eocene of other parts of the Pacific Coast. Isolated outliers of Eocene rocks occur in many localities such as Crescent Bay

[1]Willis, Bailey, and Smith, Geo. O., Tacoma Folio, U. S. Geol. Surv. 1899.

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along the Strait of Juan de Fuca, the low hills about Tenino and Centralia in Chehalis County and the exposures on Coal Creek north of Columbia River in Cowlitz County. At these localities only fragmentary sections of the Eocene column of Washington can be studied. The region under discussion in this paper contains the most complete fossiliferous marine section occurring within the western portion of the state.

REVIEW OF LITERATURE

One of the earliest important scientific references to the geologic conditions in this region is to be found in the report by Dr. Ralph Arnold[2] on "The Tertiary and Quaternary Pectens of California." He described *Pecten landesi* from this area. The following quotation is well worth noting: "*P. landesi* is found quite abundantly in a dark greenish sandstone bed that outcrops about 100 yards west of the junction of Stillwater and Olequah creeks (U. S. Nat. Mus. locality 4019) one-fourth mile southwest of Little Falls, Lewis County, Wash. It is also found in a similar matrix in the bed of Olequah Creek (U. S. Nat. Mus. locality 4024), one mile north of the first locality. It is associated in this formation with a characteristic Eocene fauna, among which are the following species: *Venericardia planicosta* Lamarck, *Thracia dilleri* Dall, *Crassatellites* sp., *Meretrix* sp., *Ostrea* sp., *Pteria* (cf.) *limula* Conrad, *Cardium* 2 sp., *Barbatia* sp., *Glycimeris* sp., *Corbula* sp., *Callista* sp., *Turritella* (cf.) *uvasana* Conrad, *Fusus* 4 sp., *Ocinebra* sp., *Ranella* sp., *Galyptrophorus* sp., *Lunatia* sp., *Turbinella* (?) sp., *Murex* 2 sp., *Conus sp.*, *Cassis* sp., *Tritonium* sp., *Dentalium* (cf.) *cooperi* Gabb, and *Nautilus* sp. This horizon is probably upper Eocene, possibly above the Tejon." Dr. Arnold's suggestion that this horizon is very high in the Eocene seems to be well in accord with more recent studies.

The Geology and Paleontology of this area is discussed in a paper by the writer[3] published in 1912. A large fauna was noted as occurring along the banks of Cowlitz River about one

[2]Arnold, Ralph, The Tertiary and Quaternary Pectens of California. Professional Paper 47, U. S. Geol. Surv., p. 52, 1906.
[3]Weaver, C. E., "A Preliminary Report on the Tertiary Palaeontology of Western Washington," Bull. 15, Wash. Geol. Surv., pp. 12-15, 1912.

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and one-half miles east of the town of Vader in Lewis County. Many new species of mollusks were described and the fauna as a whole was referred to the Cowlitz formation which was regarded as of Eocene age and possibly older than the Tejon. A suggestion was, however, made that future studies might show that it was identical with the Tejon.

A further discussion of this region is to be found in a report by Arnold and Hannibal[4] on "The Marine Tertiary Stratigraphy of the North Pacific Coast of America." In this paper the Tejon is divided into three formations: the Chehalis, Olequah and Arago formations. They are referred to as the Tejon Series. The Chehalis and Olequah formations are present in the region involved in this report. The Arago is absent. On the basis of fossil floras colder climatic conditions obtained during the deposition of the Chehalis formation than during that of the Olequah.

During the last year an important paper appeared by Dr. Roy E. Dickerson[5] entitled the "Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington." Collections were made and studied from certain localities along the Cowlitz River and a number of new species were described. A total of 95 species are listed from Washington and 55 of these are found within the Tejon of California. The paper gives the results of studies at the type Tejon locality in southern California and makes correlations with the Cowlitz phase of the Tejon in Washington. He states "The Cowlitz phase of the Tejon of Washington appears to represent the same faunal facies as the fauna of the type Tejon, i. e., the Rimella simplex zone is present in both localities."

GEOGRAPHY OF AREA UNDER INVESTIGATION

The region involved in this study is situated in southern Lewis County and extends from the town of Winlock southerly for a distance of fifteen miles to the town of Castle Rock. From east to west the area averages five miles in width. Just east

[4]Arnold, Ralph, and Hannibal, Harold, The Marine Tertiary Stratigraphy of the North Pacific Coast of America, Proc. Am. Phil. Soc., vol. 52, pp. 566-571, 1913.

[5]Dickerson, R. E., "Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington." Cal. Acad. Sci. Proc., 4th series, vol. 5, pp. 35-51, 1915.

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of the town of Vader (formerly known as Little Falls and Sopenah) the Cowlitz River swings from its east-west course and assumes a due north-south direction. One mile south of Vader, Stillwater Creek enters Cowlitz River and about one-fourth mile south of the town, Olequah Creek joins Stillwater Creek. From this point Olequah Creek extends almost due north to Winlock. The Northern Pacific Railway between Portland and Seattle follows the valley of this creek.

The drainage of the entire area is southerly to the Columbia and the hills on either side rise gradually into a rolling timbered country. Eocene strata away from the banks of the creeks are not exposed but are covered with gravels and sands formerly deposited by Cowlitz River.

STRATIGRAPHY

In the examination of this region a transit survey was made of Stillwater and Olequah creeks and the position of all fossil localities as well as observations taken upon strikes and dips definitely located. These data have been plotted upon the map accompanying this report.

Between the towns of Castle Rock and Olequah only four exposures of Eocene strata are known to occur. They consist of dark gray, sandy shales with intercallated basaltic flows. Two miles north of Castle Rock and 2,000 feet south of the Northern Pacific Railway bridge over Toutle River, there is an exposure in the railway cut composed of bedded tuffaceous materials together with sedimentary deposits of worked over basalt. These beds have a strike of N. 75° E. and a dip of 5° N. W. They are overlaid with Pleistocene deposits composed of sand and gravel intermixed with angular fragments of basalt, which appear to have been derived by rapid erosion from nearby bluffs of Eocene basalt.

From this point northerly for a distance of two miles the only exposures along the railway consist of Pleistocene gravels and sands. One and two-thirds miles north of the Toutle River bridge Eocene rock outcrops occur for a distance of 450 feet. The bluffs at this point are about 60 feet high and con-

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sist of thinly bedded, fine-grained, dark brown shale containing a few narrow bands of sandstone. The total thickness of the sediments at this point is about 75 feet. They are overlaid with 35 feet of black basalt showing well defined columnar jointing. Both the sedimentaries and lavas have a strike of N. 80° E. and a dip of 10° to the N. W.

About one-half mile south of the railway bridge across Cowlitz River there is a third exposure of Eocene basalt but no sedimentary rocks. The lower portion of the bluff is made up of agglomeratic materials consisting of a heterogeneous mass of angular fragments of badly weathered, dense and vesicular basalt having a thickness of 20 feet. Above this is a flow of fine grained, dense, black basalt exhibiting a tendency to columnar structure. The approximate strike of these flows is nearly east and west with a low dip to the north. The eroded surface of this outcrop is overlaid with Pleistocene sands and gravels.

One-half mile north of the previously mentioned outcrop, and along the south bank of Cowlitz River at the railway bridge, basalts and sedimentary rocks again appear. At the south end of the bridge and along the river there is a quarry composed of basalt exhibiting pronounced columnar structure. Lying conformably below the basalts are dark shales and brown sandstones, which in places contain narrow carbonaceous bands. They are about 60 feet in thickness with a strike of N. 35° W. and a dip of 10° to the N. E. From this point northward to the town of Olequah no recognizable exposures of the Eocene occur.

At one of the above mentioned localities a single specimen of *Turritella uvasana* Conrad was collected, but aside from this, the only fossils occurring are a few plant fragments and wood. From observations taken upon strike and dip there appears to be a continuous low dipping series of sedimentary beds with intercallated basaltic flows extending from Castle Rock to Olequah. However, it is possible that there may be folding and faulting in the intervening covered areas. If the strata are continuously dipping northward they possess a thickness of at least 6000 feet. From Olequah northward to Winlock, where the strata are better exposed, a stratigraphic sec-

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tion can be made. The sediments in the area between Castle Rock and Olequah are stratigraphically below those outcropping between Olequah and Winlock.

Section between Olequah and Winlock:—Strata of Eocene age outcrop in the banks of Olequah and Stillwater creeks and also along the railway track at many places between Olequah and Winlock. They consist predominately of massive, sandy, clay shales together with grayish brown sandstones containing carbonaceous seams. These materials are of marine, brackish and fresh water origin. With the exception of the basal portion of this section, basaltic flows are absent. The basal part involves certain sandstones and basalts outcropping at the town of Olequah. The upper portion of the section is two miles south of the town of Winlock. The actual contact of the upper limit of the Tejon and the overlying Oligocene has not been definitely determined. Four hundred feet south of the last Oligocene outcrop in the banks of Olequah Creek are Eocene shales containing a marine Tejon fauna. It is impossible to say whether the two formations are conformable or not. The strata have approximately the same strike, but the dip of the Oligocene is only 2° to the northeast, while that of the Tejon is 27° in the same direction. It is possible that the two formations are conformable but that in the interval of 400 feet between them the dip flattens out.

The lower portion of this section as exposed along Stillwater Creek to the southwest of Vader and as far south as Olequah is of marine origin. Stratigraphically above, these strata grade into those of brackish water origin and finally into those containing a freshwater fauna. Still higher up in the section they pass back to a brackish water condition and finally to marine. The entire upper portion of the section is a marine deposit. The total thickness of the Eocene section, as measured from Olequah to Winlock, is approximately 4970 feet.

The following stratigraphic section shows approximately the variations in the lithologic character of the sediments from the base to the top, including a part of the overlying Oligocene.

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TOP OF SECTION	Feet
Banded sandstone and shale as exposed at the town of Winlock and in the banks of Olequah Creek to the west and northwest of town. The fauna occurring at Locality No. 229 is characteristic of this zone	500
Massive clay shale grading in places into sandy shale as exposed along the banks of Olequah Creek south of Winlock and also in the bank of Cowlitz River in Section 5, Township 11 North, Range 2 West, at fossil Locality No. 239 (locally known as the Graeco Ranch). This is the base of the Oligocene in this region	600
Top of Eocene section. Chiefly sandy shale grading into massive clay shale of a dark brownish gray color. Exposures representing this phase are not very abundant but contain occasional specimens of *Venericardia planicosta* Lamarck and *Turritella uvasana* Conrad	960
Shaly sandstone	100
Slightly banded sandy shale	130
Slightly carbonaceous sandy shale	50
Sandy shale	430
Laminated sandstone and sandy shale	150
Shale, slightly sandy. The upper part of this zone contains an abundant marine Tejon fauna	340
Massive clay shale containing the fauna at Localities Nos. 1, 1a, 232 and 233, in the north bank of Cowlitz River, Section 25, Township 11 North, Range 2 West	50
Sandy clay shale. This is the base of the upper marine division of the section	70
Brackish water zone. Yellowish brown sandstone with interbedded lignitic layers. These sandstones often grade into carbonaceous sandy shales	520
Freshwater zone. Light gray massive clay shale, containing numerous freshwater Eocene invertebrates. Fossil Localities Nos. 295 and 303 occur in these shales	130
Lower brackish water zone. Sandy shales and shaly sandstones often grading into brownish yellow coarse grained sandstones. All are more or less carbonaceous. Fossil Localities Nos. 231, 234 and 300 occur within this zone	550
Lower marine zone. Sandy clay shales grading into shaly sandstones. Fossil Localities Nos. 240, 240b, 299, 241, 238, 301, 236, 298, 294 and 294a occur within this zone. The basal portion of this belt contains a few very narrow layers of brackish water sediments. Below this belt no detailed measurements of the strata have been made. The underlying strata are those involved in the area between Castle Rock and Olequah. Just below the base of these marine beds, flows of basalt and deposits of basaltic tuff are intercallated with the sediments, which appear to be predominatingly of brackish water origin.	390
Total thickness of measured strata between Olequah and Winlock	4,970
Possible thickness of unmeasured strata involved in area between Castle Rock and Olequah	6,000
Possible total thickness of Eocene as exposed in the lower Cowlitz Valley section	10,970

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STRUCTURE

The entire series of Oligocene and Eocene deposits involved in this region exists in the form of a northeasterly low dipping monocline. It is probably the southwestern limb of a broad syncline, the northeastern limb of which occurs in the region around Chehalis and Centralia. There are minor undulations in the northeasterly pitch of the strata between Olequah and Winlock. In the vicinity of Vader a low, shallow anticline has been developed whose axis trends N. 30° W. It crosses Olequah Creek one-half mile north of Vader. The strata on the north side of this minor fold dip to the northeast at an angle of 40° and on the southwest side at an angle of 15°. One thousand feet south of the axis of the minor anticline there is a shallow syncline having approximately the same trend as the anticline. At the point where the axis of the anticline crosses Olequah Creek the same marine strata are brought to the surface which occur to the southwest of Vader along Stillwater Creek above its junction with Olequah Creek.

A glance at the map accompanying the report indicates several apparent discordances in strike and dip in the vicinity of Olequah. It might be inferred that the strata had been greatly disturbed and faulted. However, such is not the case. There are simply minor undulations in strike and dip along the prevailing direction of strike. The variations as shown upon the map were inserted for the purpose of emphasizing these irregularities.

FAUNAL RELATIONS

In constructing the stratigraphic section accompanying this paper an attempt was made to arrange the fossil localities in their stratigraphic sequence. The following localities range from the base near Olequah to the upper portion of the section near Winlock: Localities Nos. 299, 5, 236, 298, 294, 294a, 241, 238, 301, 231, 234, 300, 295, 1, 1a, 232, 233, 239, 292 and 229.

Localities 299 to 301 contain a marine fauna. Localities 231 to 300 contain a brackish water fauna. Localities 295 and 303 contain a freshwater fauna. Localities Nos. 1 to 233

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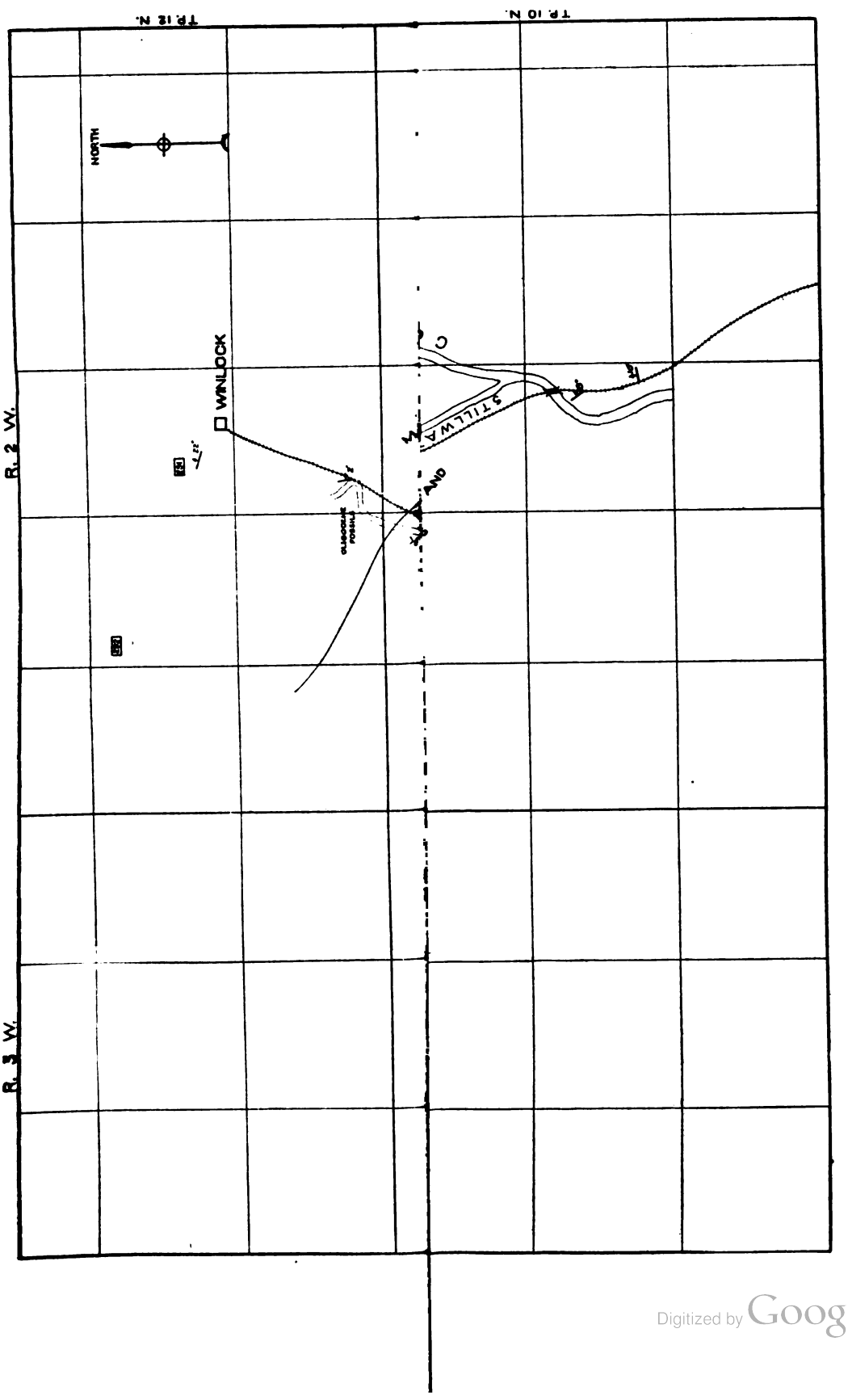

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contain a marine fauna. Localities Nos. 239 to 229 have a marine Oligocene fauna.

A description of the locations of the several fossil localities is here inserted.

Locality No. 299—From an embankment along the Northern Pacific Railroad, 2850 feet south of milepost 76 and three-fourths of a mile north of Olequah Station, in Section 32, Township 11 North, Range 3 West.

Locality No. 5—From a fossil ledge at the junction of Olequah and Stillwater creeks, in Section 32, Township 11 North, Range 3 West.

Locality No. 236—On Stillwater Creek, Lewis County, 2200 feet above its junction with Olequah Creek, in Section 30, Township 11 North, Range 2 West.

Locality No. 298—About 100 feet west of Locality No. 236.

Locality No. 294—In the bank of Stillwater Creek about one and one-third miles below its junction with Olequah Creek in Section 30, Township 11 North, Range 2 West.

Locality No. 294a—An earlier collection made at same Locality as No. 294.

Locality No. 241—In the bank of Stillwater Creek about one and two-fifths miles below its junction with Olequah Creek, in Section 30, Township 11 North, Range 2 West.

Locality No. 238—On Olequah Creek three-fourths of a mile north of Vader Station in the east bank of the creek just north of a point where a small creek enters Olequah Creek from the east. In Section 29, Township 11 North, Range 2 West.

Locality No. 301—From the banks of Olequah Creek one-half mile north of Vader and south of the four-foot falls in the creek. The strata vary from a shaly sandstone to a sandy shale.

Locality No. 231—Fossil Locality No. 234 should also be considered with No. 231, as they are both from the same locality, but from two separate ledges only eight feet apart. From Olequah Creek about three-fourths of a mile north of Vader, just south of the big bend in the creek. A small band of fossils. In Section 28, Township 11 North, Range 2 West.

Locality No. 234—A narrow band in Olequah Creek about three-fourths of a mile north of Vader, just south of big bend in creek. About eight feet stratigraphically above Locality No. 231.

Locality No. 300—On Olequah Creek one-fourth mile above Vader Station, in east bank of creek just north of point where small creek enters from east. In Section 29, Township 11 North, Range 2 West.

Locality No. 295—Located about one and one-half miles north of Vader, in the bend in Olequah Creek at the point where the creek lies close to the Northern Pacific Railway track at milepost No. 73. The fauna is entirely of fresh-water origin and is in a belt of gray shale.

Locality No. 1—Located about one and one-half miles east of Vader, on the west bank of Cowlitz River, in massive sandy shales of marine origin, situated in Section 27, Township 11 North, Range 2 West.

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Locality No. 1a—A zone at the base of the section as represented at Locality No. 1.

Locality Nos. 232 and 233—A second collection made at Locality No. 1 and kept separate from No. 1.

Locality No. 239—Located in the N.E.¼ of Section 25, Township 11 North, Range 2 West, on the east side of Cowlitz River three-fourths of a mile above the ferry on Mr. Greece's ranch. The fauna is Oligocene and is the equivalent of the faunas occurring south of Winlock in Olequah Creek at Localities Nos. 292 and 229.

Locality No. 292—Oligocene, one mile south of Winlock in bank of Olequah Creek.

Locality No. 240—An Eocene locality south of Vader in the banks of Stillwater Creek at a dam near the lumber mill. The locality is just east of the Northern Pacific Railway bridge over the creek. The strata are sandy shales and sandstones dipping at low angles to the northeast. Immediately above these strata brackish water species appear.

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Faunal Lists

Locality	299	5	236	298	294	294a	241	238	301	231	234	300	295	1	1a	232	233	240
BRACHIOPODA																		
Terebratulina washingtoniana **Weaver**														×		×		
PELECYPODA																		
Acila washingtonensis Weaver														×	×		×	
Avicula pellucida Gabb														×				
Barbatia morsei Gabb	×	×			×	×	×	×	×					×	×	×	×	×
Cardium brewerii Gabb	×	×	×	×	×	×	×	×	×					×	×	×	×	×
Cardium cooperii Gabb		×	×	×										×		×		
Cardium olequahensis Weaver		×			×	×	×											×
Corbula hornii Gabb			×	×											×	×	×	
Corbula, new species															×			
Corbicula cowlitzensis Weaver										×	×							
Crassatellites grandis (Gabb)														×	×	×	×	
Crassatellites cowlitzensis **Weaver**					×	×	×							×		×		
Crassatellites dalli **Weaver**			×	×	×	×	×											
Crassatellites merriami **Weaver**																		×
Crassatellites washingtoniana Weaver	×				×	×	×	×	×					×				
Crassatellites compacta Gabb								×	×									×
Cyrene brevidens White	×									×	×							×
Corbicula cowlitzensis Weaver																		
Diplodonta polita (Gabb)														×	×	×		
Glycimeris eocenica Weaver														×		×		×
Glycimeris sagittata (Gabb)		×	×	×	×	×	×							×	×	×	×	
Glycimeris eocenica landesi Weaver																		×
Leda gabbi Conrad		×	×	×										×	×	×	×	
Leda vaderensis Dickerson															×		×	
Marcia quadrata (Gabb)														×	×	×	×	
Macrocallista (?) *andersoni* Dickerson														×	×	×		
Macrocallista conradiana (Gabb)					×	×	×	×	×					×	×	×	×	×
Macrocallista vaderensis Dickerson															×		×	
Meretrix olequahensis Weaver															×		×	
Meretrix ovalis Gabb								×	×					×	×		×	
Meretrix wvasana Conrad			×	×	×	×	×							×		×		×
Meretrix hornii Gabb			×	×	×	×	×	×	×					×	×	×		×
Meretrix longa Gabb					×	×	×							×		×		
Meretrix, new species								×	×									
Modiolus ornatus (Gabb)	×	×			×	×	×							×		×		
Ostraea fetlkei Weaver					×	×	×								×		×	×

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FAUNAL LISTS—(Cont.)

Locality	299	5	236	298	294	294a	241	238	301	231	234	300	295	1	1a	232	233	240
Ostraea idriaensis Gabb					×	×	×								×		×	×
Ostraea oleqaahensis Weaver															×		×	
Pecten cowlitzensis Weaver																	×	
Pecten landesi Arnold		×															×	×
Placunanomia inornata Gabb														×	×	×		
Psammobia hornii (Gabb)					×	×	×								×		×	×
Semele diaboli Dickerson															×		×	
Septifer dichotomus Gabb								×	×						×		×	
Solen parallelus Gabb	×				×	×	×							×	×	×		
Solen lincolnensis Weaver															×		×	
Thracia dilleri Dall															×		×	
Tellina sutterensis Dickerson														×		×		
Tellina longa Gabb								×	×						×		×	
Tellina hornii Gabb		×			×	×	×	×	×					×	×	×		
Tellina mathewsonii Gabb								×	×									
Teredo, sp														×	×	×	×	
Unio transpacifica Arn. & Hann													×					
Venericardia planicosta hornii (Gabb)	×	×			×	×	×	×	×					×	×	×	×	×
SCAPHOPODA																		
Dentalium stramineum Gabb		×						×	×					×	×	×	×	×
Cadulus pusillus (Gabb)															×		×	
GASTEROPODA																		
Amauropsis alveata (Conrad)	×	×						×	×					×		×		
Amphissa eocenica Weaver															×		×	×
Amphissa packardi Weaver															×		×	
Ancillaria bretzi Weaver														×	×	×	×	
Ambloxus olequahensis Arn. & Hann													×					
Bursa washingtoniana Weaver														×	×	×	×	
Bursa cowlitzensis Weaver														×		×		
Brachysphingus clarki Weaver		×													×		×	
Calyptraea excentrica (Gabb)	×	×			×	×	×	×	×					×	×	×	×	×
Crepidula pileum Gabb														×	×	×	×	
Crepidula, new species															×		×	
Cylichna costata Gabb	×	×												×	×	×	×	
Cancellaria stantoni Dickerson															×		×	
Cantharus perrini Dickerson															×		×	
Conus hornii Gabb															×		×	

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FAUNAL LISTS—(Cont.)

Locality	299	5	236	298	294	294a	241	238	301	231	234	300	295	1	1a	232	233	240
Conus remondii Gabb	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Conus weaveri Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Conus cowlitzensis (Weaver)	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Drillia ornata Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Exilia dickersoni Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	X	X	X	....
Exilia perkinsiana (Cooper)	....	....	....	....	....	....	....	....	....	....	....	....	....	X	X	X	X	....
Ficus mamillatus Gabb	....	X	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
***Ficus*, new species**	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Fusus washingtoniana Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Fusus lewisensis Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	X	X	X	....
Fusus willisi Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Fasciolaria buwaldana Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Fasciolaria washingtoniana Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Ficopsis remondii Gabb	....	....	....	....	....	....	....	....	....	....	....	....	....	X	X	X	X	....
Ficopsis cowlitzensis Weaver	....	X	....	....	X	X	X	....	....	....	....	....	....	X	....	X	....	X
Galeodea washingtoniana Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....
Galeodea tuberculata (Gabb)	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Hemifusus sopenahensis Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	X
Hemifusus lewisiana Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....
Hemifusus washingtoniana Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Hemifusus tejonensis Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....
Lunatia cowlitzensis Dickerson	....	X	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Lunatia nuciformis Gabb	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....
Lunatia washingtonensis Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Mitra washingtoniana Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	X	X	X	....
Murex cowlitzensis Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Murex sopenahensis Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Murex packardi Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Melania packardi Dickerson	....	....	....	....	....	....	....	....	....	X	X	....	....	....	X	....	X	....
Melania vaderensis Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....
Melania fettkei Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Melania lewisiana Weaver	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Monodonta wattsi Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....
Neverita weaveri Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....	....
Neverita secta Gabb	X	....	....	....	X	X	X	X	X	....	....	....	....	X	....	X	....	X
Neritina martini Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....
Nerita cowlitzensis Dickerson	....	....	....	....	....	....	....	....	....	....	....	....	....	....	X	....	X	....
Nerita triangulata Gabb	....	....	....	....	X	X	X	....	....	....	....	....	....	X	....	X	....	....
Naticina obliqua Gabb	....	....	....	....	X	X	X	X	X	....	....	....	....	....	X	X	X	....

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FAUNAL LISTS—(Cont.)

Locality	299	5	236	298	294	294a	241	238	301	231	234	300	295	1	1a	232	233	240
Neverita subglobosa Gabb														×	×	×		
Nyctilochus washingtoniana Weaver														×		×		
Niso politu Gabb														×		×		
Odostomia packi Dickerson															×		×	
Olivella mathewsonii Gabb															×	×		
***Olivella*, new species**														×	×	×	×	
Packyhilus drakei Arn. & Hann													×					
Pseudoliva inornata Dickerson		×												×	×	×		
Pseudoliva volutaeformis Gabb		×											×	×	×			
Rimella elongata Weaver													×	×	×	×		
Rimella simplex Gabb													×	×	×	×		
Siphonalia bicarinata Dickerson														×	×	×		
Surcula washingtoniana Weaver													×		×			
Surcula cowlitzensis Weaver													×	×	×	×		
Sinum obliquum (Gabb)		×						×	×				×		×			
Turris washingtoniana (Weaver)													×	×	×			
Turris pulcher Dickerson													×		×			
Turris monolifera Cooper														×	×	×		
Turritella uvasana Conrad	×	×			×	×	×	×	×				×	×	×	×		×
Turritella, new species														×	×	×		
Turritella, new species														×				
Turritella, new species														×	×	×	×	
Triforis washingtoniana Dickerson															×		×	
Urosalpinx hannibali Dickerson														×	×	×	×	
Vipiparus washingtoniana Arn. & Hann													×					
CEPHALOPODA																		
Aturia mathewsonii Gabb														×		×		
***Aturia*, new species**														×	×	×	×	

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The above listed faunas are typically Tejon. The Cowlitz phase of the Tejon as represented at Locality No. 1 on the Cowlitz River one and one-half miles east of Vader was in a previous paper by the writer regarded as older than the Tejon, and more closely related to it than to the Martinez of California. Since the publication of that report more extensive collections have been made, as well as more detailed stratigraphic studies. The faunal evidence now points directly to its Tejon age. Dr. Dickerson[6] believes it is to be correlated with the type Tejon of Grapevine Canyon in southern California. He considers it to represent the middle division of the Tejon or Rimella simplex zone.

Arnold and Hannibal[7] in their report on "The Marine Tertiary Stratigraphy of the North Pacific Coast of America" consider two divisions of the Tejon to be present in the Olequah Creek region. The lower division or Chehalis formation is described as occurring at "the bluffs along Cowlitz River below the mouth of Drew Creek, one and one-half miles east of Olequah." It is apparent that they must have meant Vader rather than Olequah, as Cowlitz River is less than one-half mile east of Olequah, and the only rock exposures in that region are deposits of Pleistocene gravels and sands. Their faunal locality, No. 113, is probably the same as Locality No. 1, 1a, 232 and 233 of this report and California Academy of Sciences Localities Nos. 182 and 183, as referred to in Dr. Dickerson's report. Detailed stratigraphic measurements made with a transit show that the strata occurring at the above mentioned localities are stratigraphically higher than the strata exposed along Olequah Creek from a point two miles north of Vader southward to Olequah. The type locality of the Olequah formation as described by Arnold and Hannibal "extends from the Erwing ranch a little over two miles above Little Falls southward down Olequah Creek to Olequah, a distance of about five and one-half miles."

In this area, where both the Chehalis and Olequah formations are described as occurring by Arnold and Hannibal, stratigraphic evidence shows their lower division or Chehalis for-

[6]Dickerson, Dr. R. E., "Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington." Cal. Acad. Sci. Proc., 4th series, vol. 5, pp. 39-51.
[7]Op. Cit.

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mation to rest upon their upper or Olequah formation. Their evidence for two divisions here seems to have been based in part upon the evidence of fossil floras. An examination of the faunas obtained at various intervals from the base of section at Olequah to near the top at Winlock shows very little difference in their composition. It is true that near the middle of the section brackish and fresh water beds appear, but the marine faunas below and above are very similar. A comparison of the faunas occurring in the Eocene strata of the Cowlitz River area with those which have been listed and described from the type Tejon in southern California leads the writer to the same conclusions as have been stated by Dr. Dickerson, namely, that the Tejon of the Cowlitz River area is the equivalent of the middle zone in California as represented in the Mount Diablo region.

CONDITIONS OF DEPOSITION

The Eocene of western Washington is widely distributed. It extends well up into the western portions of the Cascade Mountains and may even possibly connect beneath a thick covering of Miocene lavas with the Eocene deposits on the eastern slopes of the mountains. The Eocene deposits involved within the western slopes of the Cascades are almost entirely of brackish or fresh water origin. No marine strata are known to be interbedded. In the Puget Sound Basin, brackish water deposits predominate, but in southwestern Washington great thicknesses of marine deposits are interbedded. During the upper Eocene the larger part of southwestern Washington and a portion of the Puget Sound Basin appear to have been an embayment of the ocean. The present site of the western slopes of the Cascade Mountains seems to have been in part occupied by large estuaries. During Tejon time diastrophic movements were differentially acting upon the entire western portion of the state, causing fluctuations in the depth of water in the embayments and estuaries and a shifting of the shorelines. These oscillations are recorded in the interbedded character of the marine and brackish water sediments. The eastern shoreline of the southwestern Washington embayment appears to have existed at times along the present site of the Northern

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Pacific Railway line from Centralia to Portland. An interpretation of the stratigraphic section shows that this shore line was alternately shifting east and west as the sea floor was being differentially elevated and depressed. The effect of those diastrophic movements as recorded within the area involved in this paper may be seen in the passage from marine to brackish and fresh water and thence back again to marine. The marine faunas as listed above indicate tropical climatic conditions and an environment ranging from shallow water to moderately deep water.

CONCLUSIONS

Within the area studied between Winlock and Olequah there are about 4000 feet of shales and shaly sandstones of upper Eocene age. Beneath these, between Olequah and Castle Rock, there are possibly 6000 feet of unmeasured upper Eocene sandstones and shales, together with numerous intercallated layers of basaltic lavas. Overlying the Eocene in the vicinity of Winlock and at the Graeco ranch on Cowlitz River are marine deposits of Oligocene age. A section of the Eocene measured between Olequah and Winlock consists of a lower division of marine beds at least 400 feet in thickness. This is overlaid by 550 feet of brackish water strata and that in turn with 300 feet of freshwater beds. Above the freshwater beds are 520 feet of brackish water strata. Above these are marine beds having a thickness of 2410 feet. These strata are all fossiliferous and appear to be most closely related to the middle Tejon as described in the Mount Diablo region of central California.

The basement upon which the Tejon in this area rests, as in the case of most of western Washington, is unknown. The fauna of the upper portion of the Cowlitz section bears a close relation to the overlying Molopophorus lincolnensis zone of the lower Oligocene as represented to the north in the vicinity of Lincoln Creek, in Thurston County.

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II

THE POST-EOCENE FORMATIONS OF WESTERN WASHINGTON

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INTRODUCTION

Marine deposits of post-Tejon age form a considerable part of the formations exposed at the surface in western Washington. They have been folded and eroded, and, in some areas, are deeply buried beneath sand and gravel of glacial and fluviatile origin. As a result, outcrops are usually found in the form of low cliffs along the banks of rivers and creeks or along the sea cliffs of the Sound or ocean. Certain portions of these Oligocene-Miocene formations yield fairly abundant marine invertebrate faunas. Upon a faunal basis five separate divisions of the post-Tejon portion of the Tertiary can be recognized. Marine deposits of Pliocene age with the exception of a very small area on the western side of the Olympic Peninsula are unknown within the state. The uppermost division or upper Miocene is separated from the lower four divisions by a well-marked unconformity. The pre-Pleistocene formations of the southwestern portion of the state are somewhat ob-

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scured by clays, sands and gravels of fluviatile origin. In many areas the Tertiary rocks themselves have been so deeply weathered that very little information can be obtained concerning their lithologic character and structure. All parts of western Washington are clothed with a dense growth of forest and underbrush, which conceals many exposures of Tertiary rocks which are not covered with Pleistocene sands and gravels.

LITERATURE

Numerous references to the occurrence of Tertiary strata may be found in papers dealing with the geology of western Washington. The majority of these papers involve investigations of economic products such as coal and contribute little to the purely scientific phases of Tertiary geology. Only the more important literature is here reviewed.

James D. Dana referred to Tertiary strata in the report on the geology of the United States Exploring Expedition under Wilkes[1] as occurring to the north of Columbia River and along the shores of Puget Sound and the Strait of Juan de Fuca. Collections were made from the south side of Columbia River at the town of Astoria. This fauna was identified by Conrad, who regarded it as Miocene.

Marine Neocene deposits are mentioned by Dr. Bailey Willis as occurring near Seattle immediately north of the northern limits of the Tacoma quadrangle.[2] These deposits are not described.

The first detailed description of the occurrence of Oligocene-Miocene strata within the state is to be found in a report by Dr. Ralph Arnold[3] on a "Geological Reconnaissance of the Coast of the Olympic Peninsula, Washington." Oligocene-Miocene deposits are described as occurring along the northern border of the Olympic Peninsula. Pliocene deposits are mentioned as being present on the west coast of the peninsula near the mouth of Queniult River. The Miocene deposits are composed of conglomerates, sandstones and shales which at-

[1]Dana, J. D., in U. S. Exploring Expedition, under command of Charles Wilkes, U. S. N., Philadelphia, vol. 10, 1838-1842.
[2]Willis, Bailey, Tacoma Folio, No. 54, U. S. Geological Survey, 1896.
[3]Arnold, Ralph, Bulletin Geological Society of America, vol. 17, pp. 451-468, September, 1906.

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tain a thickness of 15,000 feet and have been folded into anticlines and synclines. Upon the basis of faunal evidence he states that the fossils of the formation indicate that the basal portion of the series is Oligocene in age, while the upper part is certainly Miocene. Since the separation of the two members will necessarily have to be made on paleontological grounds and will require a more detailed study of the material in hand than time has yet permitted, the term "Oligocene-Miocene series" will be used temporarily to designate the age of the beds. Arnold applied the term to this formation and recognized five faunal zones within it.

Further mention is made concerning the occurrence of Oligocene and Miocene fossils at Restoration and Beans points, just west of Seattle, by Dr. Ralph Arnold[4] and Dr. W. H. Dall.[5]

A paper published in 1908 by A. B. Reagan[6] and entitled "Some Notes on the Olympic Peninsula," describes the Tertiary rocks occurring in certain localities along the north and west sides of the Olympic Peninsula. Several new species of mollusks are described and figured.

In 1911, the writer, in a preliminary paper on the Tertiary of western Washington, described in a general way the distribution of the Miocene formations within the state. The following subdivisions were made: Lincoln formation of Oligocene age; Blakeley, Wahkiakum and Chehalis formations of Lower Miocene age, and the Montesano of Upper Miocene. Since the appearance of that paper, more detailed field work has been done by the writer. As a result, a large portion of the Chehalis formation is now included within the Wahkiakum and Montesano formations, and another division intermediate between the Lincoln and Blakeley is introduced, namely, the Porter.[7] The area along the western border of the Olympics represented upon the map accompanying the report as undifferentiated Lower Miocene, is of probable Jurassic age and is now referred to as the Hoh formation.

[4]Arnold, Ralph, Professional Paper No. 47, U. S. G. S., "The Tertiary and Quaternary Pectens of California," Washington, 1905.
[5]Dall, W. H., Professional Paper No. 59, U. S. G. S., "The Miocene of Astoria and Coos Bay, Oregon," Washington, 1906.
[6]Reagan, A. B., "Some Notes on the Olympic Peninsula," Kansas Acad. Sci. Geological Papers, pp. 131-238, 1908.
[7]Weaver, C. E., "A Preliminary Report on the Tertiary Palaeontology of Western Washington," Bulletin No. 13, Washington Geological Survey, 1911.

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The most recent paper on the Tertiary of western Washington is by Arnold and Hannibal[8] on the Marine Stratigraphy of the North Pacific Coast of America, published in 1913. A four-fold division of the Oligocene is recognized. The oldest is represented by the Sooke formation of southwestern Vancouver Island. This is followed by the San Lorenzo, Seattle and Twin River formations. Above this is the Monterey, which is thought to be in part Oligocene and possibly in part lower Miocene. The upper Miocene strata, which are described as occurring on the south and west portions of the Olympic Peninsula, are believed to be the equivalent of the Empire formation of Coos Bay, Oregon.

GEOGRAPHIC DISTRIBUTION

The Oligocene and Miocene deposits of western Washington exist in three separate areas. The largest and most representative area occupies the northern half of the Puget Sound basin and the north border of the Olympic Peninsula. A second area embraces the western portion of the Chehalis and Willapa river valleys in the southwestern part of the state. A third area constitutes a belt ranging from five to fifteen miles in width and trending east and west along the north shore of Columbia River. Within the Puget Sound basin and along the northern portion of the Olympic Peninsula, Miocene sediments are for the most part more or less heavily covered with deposits of glacial drift. They appear in the form of low sea cliffs along the shores of the entrance to the Bremerton Navy Yard, in the streets in the southern portions of the city of Seattle, and along the northern slopes of the Newcastle Hills. Along the north border of the Olympic Peninsula rock exposures appear almost continuously from Cape Flattery eastward to Port Crescent. Similar deposits occur within and along the shores of portions of the Quimper Peninsula south of Port Townsend. The Puget Sound Basin Oligocene and Miocene area is separated from that of southwestern Washington by basalts and sedimentary rocks of Eocene age. From the southern margin of the Olympic Moun-

[8]Arnold, Ralph, and Hannibal, Harold, "Marine Stratigraphy of the North Pacific Coast of America," Proc. Amer. Philos. Soc., vol. 53, No. 212, November-December, 1913.

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tains in Chehalis County, Oligocene and Miocene formations extend southerly to the middle of Pacific County. Outlying residuals occur in western Thurston and Lewis counties. Similar deposits of post-Tejon age are present in Wahkiakum County and in the southwestern part of Pacific County. They have been cut by the Columbia River and their southern extension forms a part of the well-known series of outcrops occurring at Astoria, Oregon. No marine deposits of Oligocene or Miocene age are known to occur within the Cascade Mountains or within the great basin area of eastern Washington. In these regions deposits of corresponding age are of igneous or freshwater origin.

SEDIMENTATION

From the standpoint of stratigraphy the post-Tejon sediments occurring in the western part of the state are divided into two broad groups, separated by a well-marked unconformity. The older division includes deposits of Oligocene and lower Miocene age, while the younger involves sediments of upper Miocene and possibly lower Pliocene ages. During the Oligocene, embayments of the ocean were widely extended over western Washington with the exception of the central and western portions of the Olympic Peninsula. During the lower Miocene their extent became much smaller and by the opening of the upper Miocene they were almost entirely withdrawn. During the upper Miocene two small, shallow basins of deposition were formed. One of these existed in the basin of Grays Harbor and the other near the junction of Bogachiel and Solduc rivers in southwestern Clallam County.

During the Eocene epoch, southwestern Washington was occupied by an embayment of the ocean which seems to have extended as far north as the middle portion of the present Puget Sound basin. This fact is indicated by the occurrence of narrow bands of marine strata interbedded with those of purely brackish water origin. On the eastern shores of this embayment were situated extensive estuaries in which over 10,000 feet of brackish water sediments were deposited and which now form extensive outcrops in King, Pierce and Lewis counties. Igneous activity was characteristic of the larger

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portion of the Tejon epoch but had almost entirely ceased by the opening of the Oligocene epoch. Near the close of the Eocene or at the opening of the Oligocene minor crustal movements brought about an encroachment of the marine waters into the Puget Sound basin and also into the present site of the Strait of Juan de Fuca.

In southwestern Washington the oldest deposits of post-Eocene age occur west of the city of Centralia in the valley of Chehalis River. They consist of indistinctly bedded, sandy, gray shales containing a marine invertebrate fauna which will be referred to in this report as the Molopophorus lincolnensis zone. The strata containing the fauna may be referred to as the Lincoln horizon. At the present time the strata at this locality are approximately 1,000 feet in thickness. Away from stream, railway or wagon road cuts, rock exposures are largely obscured by a veneer of sands, clays and gravels, rendering it difficult to determine the exact areal limits of these beds. Fossiliferous strata outcropping in the banks of Olequah Creek near the town of Winlock and in the banks of Cowlitz River, six miles east of Vader, at the Graeco Ranch, may have been contemporaneously deposited with those at Lincoln Creek. The same may be true of the shales on Porter Creek north of the town of Porter in Chehalis County. They are unknown to the southwest in Pacific and Wahkiakum counties, as well as along the Strait of Juan de Fuca.

Toward the close of deposition of the Lincoln sediments the Oligocene seas expanded and occupied portions of the Strait of Juan de Fuca and the Puget Sound basin, as well as most of southwestern Washington. By the close of the Oligocene epoch these deposits had attained a maximum aggregate thickness of 15,000 feet. They consist predominately of shales and sandy shales within which local beds of conglomerate and sandstone are occasionally interbedded. The thickest and most complete section of the Oligocene is to be found in northern Clallam County along the northern border of the Olympic Peninsula. The section measured between Cape Flattery and Clallam Bay possesses a thickness of 13,300 feet. The basal beds are situated at the west end of Wyatch Slough and the upper about half way between Neah Bay and Clallam Bay.

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CAPE FLATTERY SECTION

TOP

	Feet
Massive sandstone	700
Chiefly shale, mostly concealed	900
Massive sandstone	175
Chiefly shale, mostly covered	800
Massive brown sandstone	300
Concealed	500
Massive, medium grained, brown sandstone	300
Alternating bands of grayish brown shale and sandstone	1,200
Brown sandstone	200
Conglomerate	30
Brown sandstone	50
Conglomerate	50
Conglomerate with interbedded layers of shale	500
Coarse conglomerate	300
Grayish brown shale	700
Interbedded sandstone, shale and conglomerate	200
Massive, pebbly conglomerate	175
Hard, flinty shale	200
Sandstone with some interbedded shale	400
Interbedded massive sandstone and conglomerate	450
Massive conglomerate	30
Massive sandstone and intercallated conglomerate lense	300
Sandy conglomerate as exposed at Cape Flattery	1,400
Interbedded sandstone and shale	150
Concealed, probably shale	500
Laminated sandy shale	200
Interbedded conglomerate and sandstone	250
Shale	350
Gritty sandstone with some interbedded shale	250
Brown shale	1,200
Brown banded sandstone	300
Total	13,300

Structurally the strata just described are involved in the badly wrinkled southwestern limb of a syncline whose axis trends from Port Crescent northwesterly diagonally across the Strait of Juan de Fuca. The strata forming the northeasterly limb occur fringing the south coast of Vancouver Island.

Deposits of Oligocene age are well developed in the low cliffs along the entrance to the Bremerton Navy Yard. These beds are a continuation of those occurring to the east at Alki Point and South Seattle, as well as along the north flanks of the Newcastle Hills. They have been sharply folded and deeply dissected by erosion, and later covered with deposits of glacial drift. The following generalized stratigraphic section has been constructed. The lowest beds exposed in the section outcrop at Orchard Point on the south side of Brem-

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erton Inlet and the highest beds along the north shore of the entrance to Blakeley Harbor.

Top of Section

	Feet
Massive, coarse grained conglomeratic sandstones containing numerous lenticular bands of conglomerates. Occasional, narrow bands of clay shale are interbedded	1,300
Sandy shales exposed beneath the waters of Blakeley Harbor	1,400
Brownish gray, massive to slightly bedded, sandy shales as exposed along the south shore of Blakeley Harbor for a distance of one-half mile northwesterly	2,400
Shaly sandstone grading in places into a shale. Stratification well defined. Upper portion of this belt is located at Restoration Point	1,200
Shaly sandstones gradually becoming more sandy in depth. Bedding, very distinct	450
Massive, sandy shales	350
Massive, brownish-gray, coarse grained conglomeratic sandstones and interbedded bands of coarse conglomerate, the pebbles of which attain a diameter of two feet. Many of the pebbles are composed of basalt and others of light colored shale and sandstone	1,800
Total	8,900

SEQUENCE OF FAUNAS

In the report by Arnold and Hannibal on the "Stratigraphy of the North Pacific Coast," deposits of Oligocene age are referred to as the Astoria Series. This series is divided into three divisions, namely: the San Lorenzo, Seattle and Twin River formations. The distinctions between these formations are largely based upon differences of faunas rather than upon lithologic grounds. In the opinion of the writer, it would be preferable to refer to these divisions as faunal zones rather than formations. The application of the term San Lorenzo formation to the deposits described as such in Washington seems hardly justifiable. The type locality for the San Lorenzo is located in the Coast Ranges of California. Whether the strata assigned to the San Lorenzo in western Washington represent a part, all, or more than that, belonging to the formation in California, has not been determined. Until such information is available it would be misleading to make such direct correlation. If future investigations should prove that the deposits were formed contemporaneously, the term could with justice be introduced. Studies made by the writer on

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faunas collected from the type localities of the Twin River and Seattle formations do not indicate sufficient grounds for making a separation. The Seattle formation is described as occurring on the south shore of the Strait of Juan de Fuca east of Twin River and east of Gettysburg. Detailed mapping in this region shows conclusively that the strata occurring there are involved in the east and west limbs of a syncline, and stratigraphical measurements prove the strata in question on each limb of this syncline to be identical. The arguments which have just been made concerning the use of the term San Lorenzo in Washington, at present at least, may be applied to the introduction of the term Monterey and Empire. The exact use of the term Monterey has not been definitely agreed upon in California. As more and more detailed information is obtained there is divergence of opinion as to what is to be included within the meaning of the term Monterey. The faunas of Washington and Oregon are not at present sufficiently known to permit any direct correlations. Suggestions can be made, but it would seem preferable to the writer to use local names provisionally and to gather all the information possible concerning formations or faunal zones in Washington and later, when such information is at hand, both in California and Washington, to make direct correlations. Misunderstandings as to what the writers are intending to convey will be less common. The gathering and recording of accurate information in the field is much more desirable than the attempt to make broad correlations with distant areas on insufficient and imperfect field data. After detailed studies have been made, such correlations can be made with confidence. In the meantime suggested similarities can be placed on record.

Five distinct faunal zones can be recognized in the post-Tejon strata of western Washington. The following table will illustrate their sequence:

Montesano horizon—Yoldia strigata zone....Upper Miocene
—unconformity—

Wahkiakum horizon—Arca montereyana zone. Lower Miocene
—unconformity—

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Blakeley horizon—Acila gettysburgensis zone.....Oligocene
Porter horizon—Turritella porterensis zone.....Oligocene
Lincoln horizon—Molopophorus lincolnensis zone..Oligocene
Tejon group .....Eocene

MOLOPOPHORUS LINCOLNENSIS ZONE

The oldest post-Tejon fauna which has been recognized within western Washington occurs in sandy shales outcropping along the south bank of Chehalis River five to 10 miles west of the city of Centralia, in Thurston County. Fossils in this locality are fairly abundant and in an excellent state of preservation. An examination of the faunal lists from this region indicates that several of the species are identical with those occurring in the underlying Tejon Eocene. Among these are *Brachysphingus clarki* Weaver, *Leda uvasana* Dickerson, *Crassatellites washingtoniana* Weaver, *Exilia dickersoni* Weaver, *Hemifusus washingtonianus* Weaver, and *Strepsidura oregonensis* Dall.

The following species have been recognized as occurring in the rock bluffs along the south bank of Chehalis River west of Lincoln Creek. The strata containing the fauna may be referred to as the Lincoln horizon[9] and the fauna itself as the Molopophorus lincolnensis zone.

PELECYPODA

Cardium lincolnensis Weaver
Cardium lorenzanum (Arnold)
Crassatellites washingtoniana Weaver
Crassatellites cowlitzensis Weaver
Crenella porterensis Weaver
Leda uvasana Dickerson
Leda lincolnensis Weaver
Macrocallista pittsburgensis Dall
Nucula washingtonensis Weaver
Ostraea lincolnensis Weaver
Solen curtus Conrad
Solen parallelus Gabb
Pitaria dalli Weaver

SCAPHAPODA

Dentalium strainineum Gabb

BRACHIOPODA

Terebratalia, sp.

[9]The use of the term Horizon is in the sense of a deposit formed at a particular time and identified by distinctive fossils.

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GASTEROPODA

Ampullina, new species
Brachysphingus clarki Weaver
Bittium lincolnensis Weaver
Cancellaria, new species
Calyptræa washingtonensis Weaver
Drillia stanfordensis (Arnold)
Exilia dickersoni Weaver
Hemifusus washingtoniana Weaver
Drillia hecoxi (Arnold)
Lunatia cowlitzensis Dickerson
Scaphander oregonensis Dall
Surcula lincolnensis Weaver
Strepsidura oregonensis Dall
Strepsidura lincolnensis Weaver
Molopophorus lincolnensis Weaver
Turritella newcombi Merriam

The above listed fauna seems to have a closer affinity with that occurring at Porter Bluffs, about 20 miles to the west in Chehalis County, and designated in this report as the Turritella porterensis zone, than to the underlying Eocene. The most important species which occur in common are *Cardium lorenzanum* Arnold, *Crenella porterensis* Weaver, *Dentalium conradi* Dall, *Drillia hecoxi* (Arnold), *Lunatia cowlitzensis* Dickerson, and *Malletia chehalisensis* Arnold.

Marcia oregonensis Conrad, *Thyasira bisecta* (Conrad), *Thracia trapezoidea* Conrad, and *Phacoides acutilineatus* (Conrad) are entirely absent from the Molopophorus lincolnensis zone. They are, however, among the most common species to be found in the Turritella porterensis and Acila gettysburgensis zones.

The following species are most characteristic of the Molopophorus lincolnensis zone: *Cardium lorenzanum* Arnold, *Crassatellites washingtoniana* Weaver, *Leda uvasana* Dickerson, *Macrocallista pittsburgensis* Dall, *Pitaria dalli* Weaver, *Brachysphingus clarki* Weaver, *Exilia dickersoni* Weaver, *Lunatia cowlitzensis* Dickerson, *Drillia hecoxi* (Arnold) and *Strepsidura oregonensis* Dall.

A study of the faunas above listed indicates clearly a marked distinction between the Tejon fauna proper and the Molopophorus lincolnensis zone. A closer relation exists between the latter and the Turritella porterensis zone, although there are sufficient distinctions to warrant considering them separate faunal zones.

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TURRITELLA PORTERENSIS ZONE

The type locality at which this fauna may be found is located in the cliffs along the north bank of Chehalis River near the mouth of Porter Creek, in Chehalis County. Exposures of the same strata also occur in the banks of the small creeks entering Chehalis River from the north in the vicinity of Porter Creek. The most common species appearing in this zone are *Cardium lorenzanum* Arnold, *Crenella porterensis* Weaver, *Malletia chehalisensis* Arnold, *Marcia oregonensis* (Conrad), *Thracia trapezoidea* Conrad, *Thyasira bisecta* (Conrad), *Phacoides acutilineatus* (Conrad), *Drillia hecoxi* (Arnold) and *Turritella porterensis* Weaver. Such species as *Acila gettysburgensis* Reagan, *Macrocallista vespertina* (Conrad), *Modiolus directus* Dall, *Panope generosa* (Gould), *Eudolium petrosum* (Conrad), *Turcicula washingtoniana* Dall and *Turritella blakeleyensis* Weaver are absent. These species are, however, among the most characteristic occurring in the Acila gettysburgensis zone. It is possible that the Turritella porterensis zone may be represented beneath the lowermost beds of the Acila gettysburgensis zone south of Orchard Point at the Bremerton Inlet section. If so, it occurs between the lowest conglomerate belt of the Acila gettysburgensis zone and the underlying Eocene basalts near Port Orchard. This region is covered with glacial drift. The lower beds in the Clallam County area as exposed three miles west of Port Crescent may also represent this horizon.

ACILA GETTYSBURGENSIS ZONE

The type locality where this fauna may be found is in the sea cliffs about the entrance to the Bremerton Navy Yard. The lowermost strata occur at Orchard Point. The highest strata outcrop along the north shore of the entrance to Blakeley Harbor. The total thickness of the beds here exposed is 8,900 feet. Detailed stratigraphic surveys show that the conglomerates at Orchard Point are below the sandstones and shales at Bean Point. The beds at Bean Point are about 2,000 feet below the fossiliferous beds at Restoration Point. The fauna

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in the lower portion of this section is almost identical with that at the well-known locality just north of Restoration Point. In other words, there appears to be but one faunal zone represented within the strata exposed between Orchard Point at the base of the section and the north shore of Blakeley Harbor at the top of the section.

The most characteristic species of the Acila gettysburgensis zone are *Acila gettysburgensis* Reagan, *Macrocallista vespertina* (Conrad), *Marcia oregonensis* (Conrad), *Modiolus rectus* Dall, *Panope generosa* (Gould), *Phacoides acutilineatus* (Conrad), *Spisula albaria* (Conrad), *Solemya ventricosta* Conrad, *Tellina oregonensis* Conrad, *Thracia trapezoidea* Conrad, *Thyasira bisecta* (Conrad), *Crepidula praerupta* Conrad, *Eudolium petrosum* (Conrad), *Miopleiona indurata* (Conrad), *Turcicula washingtoniana* Dall and *Turritella blakeleyensis* Weaver. Such species as *Acila gettysburgensis* Reagan, *Solemya ventricosta* Conrad, *Eudolium petrosum* (Conrad) and *Turcicula washingtoniana* Dall appear for the first time in this zone. They are always among the most common species met with and are entirely absent from the Turritella porterensis and Molopophorus lincolnensis zones.

ARCA MONTEREYANA ZONE

The recognition of a fauna characteristic of the Arca montereyana zone was first mentioned as occurring in Wahkiakum County on the Alockaman River about 12 miles north of the town of Cathlamet. The strata are composed of sandstones and shales involved in a shallow synclinal trough. Deposits of sandstones and sandy shales outcropping along the Strait of Juan de Fuca from Pysht westerly to Clallam Bay, also contain a fauna belonging to this faunal zone. Similar faunas representing both deep and shallow water phases occur in the shales and sandstones in the Grays Harbor region. The sediments in which they occur were in part formerly referred to by the writer as the Chehalis formation.[10]

A complete list of the species occurring within this zone may be referred to in the faunal table on page 35. Among

[10]Bulletin No. 13, Washington Geological Survey, 1911.

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the more characteristic species occurring in this zone are *Arca montereyana* Osmont, *Chione securis* (Shumard), *Diplodonta parilis* Conrad, *Acila conradi* Meek, *Arca trilineata* Conrad, *Marcia oregonensis* (Conrad), *Pecten propatulus* Conrad, *Panope generosa* (Gould), *Phacoides acutilineatus* (Conrad), *Spisula albaria* (Conrad), *Crepidula praerupta* Conrad, *Fusinus stanfordensis* (Arnold), *Polynices saxea* Conrad, *Sinum scopulosum* (Conrad), *Dentalium conradi* Dall, *Aturia angustata* Conrad, *Pecten fucanus* Arnold, *Tellina arctata* Conrad, *Venericardia quadrata* Dall, *Venus olympidea* (Reagan), *Venus clallamensis* (Reagan), *Ficus clallamensis* Weaver, *Tellina nevadensis* Anderson, *Cancellaria dalliana* Anderson, *Cancellaria condoni* Anderson, and *Leda ochsneri* Anderson. This fauna presents a very strong similarity to that occurring in the Monterey formation in California.

YOLDIA STRIGATA ZONE

The upper Miocene strata of western Washington everywhere rest with unconformity upon the older rocks. The fauna occurring within these strata is very different from that of the faunal zones just described. One of the most common and readily recognizable species among this fauna is *Yoldia strigata* Dall. It might be desirable to refer to this fauna as the Yoldia strigata zone.

Among the more characteristic species belonging to this zone are *Arca trilineata* Conrad, *Cardium meekianum* Gabb, *Macoma astori* Dall, *Mulinia densata* Conrad, *Pecten coosensis* Shumard, *Solen sicarius* Gould, *Siliqua nuttallii* Conrad, *Yoldia strigata* Dall, *Argobuccinium cammani* Dall, *Chrysodomus imperalis* Dall, *Phalium aequisulcatum* Dall, *Sinum scopulosum* (Conrad) and *Scutella gabbii* Rémond. A complete list of the species occurring in this zone may be found in the faunal table.

Strata containing fauna of the Yoldia strigata zone outcrop in the Chehalis valley in the vicinity of Grays Harbor, at the mouth of the Queniult River and in the lower valley of the Quillayute River. The faunas of the Quillayute and Queniult valleys may represent a slightly higher position than

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those of the Chehalis Basin. Detailed studies at each of those localities will be required to determine that point.

No marine deposits are known to occur within the state younger than those near the mouth of the Queniult Basin except late Pleistocene beach sands around the shores of Puget Sound.

CORRELATION

Sufficient evidence is not as yet at hand to warrant a direct correlation of the faunas or faunal zones of western Washington with those of California. The great unconformity existing between the upper and lower Miocene is general throughout the Pacific coastal region. The faunas of both the upper and lower Miocene are distinctly different in California and Washington. The upper Miocene fauna of Washington appears to have its closest resemblance to the San Pablo of California, but more detailed evidence must be secured before such a definite correlation can be made. The Arca montereyana zone of Washington appears to be the equivalent of the same zone in California. It is possible, however, that more or less may be included within the faunal zone in the north than in the south. The Molopophorus lincolnensis and the Turritella porterensis zones of Washington may be the equivalent of the Agasoma gravidum zone of California. It is possible that the Acila gettysburgensis zone is in part higher.than the Agasoma gravidum zone in the south.

CONCLUSIONS

The post-Tejon formations of western Washington consist of shales and sandstones of marine origin. These deposits contain a well-developed fauna which at the present time is imperfectly known. The total maximum aggregate thickness of the sediments is approximately 20,000 feet.

Five well-marked faunal zones are present, the uppermost of which is separated from the lower four by a well-marked unconformity and difference in character of species. This line

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of separation is the division line between the upper and lower Miocene. The uppermost of the remaining four faunal zones is separated from the other three by well-marked faunal differences. It is lower Miocene in age while the three lower zones are Oligocene. The faunas of the Oligocene in western Washington show a gradual gradation from one zone into another.

Insufficient evidence is as yet available to warrant making direct correlations with the post-Tejon zones of California, yet suggested similarities appear.

POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON

The following table contains a list of the species occurring in the post-Tejon strata of western Washington. A large number of new and undescribed species are present, which are not included within this list.

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POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON

	Molopophorus lincolnensis Zone	Turritella porterensis Zone	Acila gettysburgensis Zone	Arca montereyana Zone	Yoldia strigata Zone	Recent	Tejon formation of Washington	Astoria	Tunnel Point Beds	Empire	Agasoma gravidum Zone	Arca montereyana, California	San Pablo	Santa Margarita	Etchegoin
PELECYPODA															
Acila conradi Meek				×	×					×			×		
Acila gettysburgensis Reagan			×												
Anomia subcostata Conrad	×														
Arca trilineata Conrad					×								×	×	×
Arca montereyana Osmont				×								×			
Cardium lorenzanum Arnold	×	×	×								×				
Cardium lincolnensis Weaver	×														
Cardium coosense Dall					×					×					
Cardium vaquerosensis Arnold				×											
Cardium meekianum Gabb					×					×			×	×	
Chione securis (Shumard)					×					×			×	×	
Chione bisculpta Dall					×					×					
Chione chehalisensis Weaver					×										
Chione montesanoensis Weaver															
Chione clallamensis Reagan				×											
Chione olympidea Reagan				×											
Chione vesperlina Conrad			×												
Chione cathcartensis Weaver			×					×							
Crenella porterensis Weaver	×	×	×												
Crassatellites washingtoniana Weaver	×														
Crassatellites cowlitzensis Weaver	×														
Cryptomya oregonensis Dall					×					×					
Cryptomya washingtoniana Weaver					×										
Diplodonta parilis Conrad				×	×	×		×		×			×	×	×
Glycimeris gabbi Dall					×					×					
Leda uwasana Dickerson	×						×								
Leda lincolnensis Weaver	×														
Leda chehalisensis Weaver				×											
Leda penita Conrad				×				×							
Leda ochsneri Anderson				×											
Macrocallista pitsburgensis Dall	×														
Marcia oregonensis Conrad		×	×	×	×			×		×			×	×	
Macoma secta Conrad					×	×							×	×	×
Macoma nasuta (Conrad)					×	×				×			×	×	×

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POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON—(Cont.)

	Molopophorus lincolnensis Zone	Turritella porterensis Zone	Acila gettysburgensis Zone	Arca montereyana Zone	Yoldia stricata Zone	Recent	Tejon formation of Washington	Astoria	Tunnel Point Beds	Empire	Agasoma gravidum Zone	Arca montereyana, California	San Pablo	Santa Margarita	Richegon
Macoma montesanonsis Weaver				XX	XX					XX					
Macoma calcarea Gmelin						X									
Macoma astori Dall			X							XX	XX				
Macrocallista vesperina (Conrad)															
Macoma clallamensis Reagan				XX											
Macoma wynoochensis Weaver															
Macoma moliana Dall			X						X						
Molopophorus gabbi Dall															
Molopophorus lincolnensis Weaver	XX														
Mytilus matheusoni Gabb				X							X		X		
Mytilus sammamishensis Weaver		X			X					X					
Mytilus condoni Dall															
Mytilus snohomishensis Weaver															
Mytilus, n. sp							X			X			X		X
Modiolus directus Dall															
Modiolus inflatus Dall															
Maletia chehalisensis Arnold	X	X		X											
Nucula dalli Arnold	XX		XXXX		XX			X			X			XX	X
Nucula washingtonensis Weaver							X								
Ostraea idriaensis Gabb					XX	X		X		X					
Ostraea wealchii Gabb			X								X		X		
Pasops generosa (Gould)		X	X	X	XXX	X		X		XXX					
Pitaria dalli Weaver	X	X	X												X
Phacoides acutilineatus (Conrad)															
Phacoides annulatus Reeves				XX											
Pecten coosensis Shumard															
Pecten propatulus Conrad															
Pecten fucanus Arnold			X								X	X			
Pecten packhami Gabb		XX													
Pecten portlandensis Weaver				X											
Pecten alockamenensis Weaver															
Pseudocardium gabbi Remond										X			X		
Pseudocardium landesi Weaver					XXX										
Semele montesanonsis Weaver															

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POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON—(Cont.)

	Molopophorus lincolnensis Zone	Turritella portorensis Zone	Acila gettysburgensis Zone	Arca montereyana Zone	Yoldia strigata Zone	Recent	Tejon formation of Washington	Astoria	Tunnel Point Beds	Empire	Agasoma gravidum Zone	Arca montereyana, California	San Pablo	Santa Margarita	Etchegoin
Semele, n. sp.					X										
Solemya ventricosiata Conrad			XX	X	X		X	XX		XX					
Solen curtus Conrad	X										X				
Solen parallelus Gabb					X	X				XX					
Solen sicarius Gould			XX	XX				X							
Solen conradi Dall		X													
Spisula albaria (Conrad)				XX	XXXX	X		XXX		XX	X				
Spisula catilliformis Conrad															
Spisula praecursor Dall								X		X					
Tapes staleyi Gabb					X			X		X					
Tellina kincaidi Weaver															
Tellina merriami Weaver				X						X					
Tellina obruta Conrad			XX	X				XX		X					
Tellina oregonensis Conrad				X		X									
Tellina arctata Conrad				X											
Tellina aragonia Dall															
Tellina nuculana Dall															
Tellina congesta Conrad			X												
Tellina nevadensis Anderson															
Thracia trapezoides Conrad			XX												
Thyasira bisecta (Conrad)		XX													
Tiliqua nuttalii Conrad															
Venericardia subtenta Conrad															
Venericardia cheholisensis Weaver															
Yoldia oregona Shumard			XX		X										
Yoldia impressa Conrad		X													
Yoldia submontereyensis Arnold															
Yoldia strigata Dall															
Yoldia sammamishensis Weaver			X		X										
SCAPHAPODA															
Dentalium stramineum Gabb	XX	X	X	X			X	X		X	X				
Dentalium conradi Dall															

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Post-Tejon Faunal Table for Western Washington—(Cont.)

	Molopophorus lincolnensis Zone	Turritella porterensis Zone	Acila gettysburgensis Zone	Arca montereyana Zone	Yoldia strigata Zone	Recent	Tejon formation of Washington	Astoria	Tunnel Point Beds	Empire	Agasoma gravidum Zone	Arca montereyana, California	San Pablo	Santa Margarita	Bichegoin
GASTEROPODA															
Amphissa oregonensis Dall				×	×					×					
Amphissa, n. sp.	×														
Argobuccinum cammani Dall					×					×					
Argobuccinum coosense Dall					×					×	×				
Baltytoma bogachieli Reagan															
Baltytoma gabbiana Dall										×					
Brachyspingus clarki Weaver	××														
Bittium lincolnensis Weaver															
Buccinum bogachieli Reagan					×										
Cancellaria washingtonensis Weaver				×											
Calyptraea filosa (Gabb)	×												×		×
Calliostoma stanlowi Arnold		×													
Calyptraea washingtonensis Weaver	×				×					×			×	×	
Calyptraea inornata (Gabb)				×											
Chrysodomus clallamensis Weaver	×				×					×			×		
Calyptraea excentrica (Gabb)											×				
Chrysodomus maxfieldi (Reagan)					×					×			×		
Chrysodomus imperialis Dall					×					×			×		
Chrysodomus bairdi Dall					×					×			×		
Chrysodomus gigenticus Reagan					×					×			×		
Columbella gausapata Dall					×					×			×		
Crepidula princeps Conrad					×					×			×		
Cymatium pacificum Dall					×					×			×		
Crepidula praerupta Conrad															
Cancellaria condoni Anderson															
Cancellaria wymoochensis Weaver															
Cancellaria dalliana Anderson															
Calliostoma cammani Dall															
Calliostoma delasmensis Weaver															
Chlorostoma arnoldi Weaver															
Cuma bipli cata Gabb															
Cylichnella petrosa Conrad															
Drillia chehalisensis Arnold															
Epitonium condoni Dall															

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POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON—(Cont.)

	Molopophorus lincolnensis Zone	Turritella porterensis Zone	Acila gettysburgensis Zone	Arca montereyana Zone	Yoldia stligata Zone	Recent	Tejon formation of Washington	Astoria	Tunnel Point Beds	Empire	Agasoma gravidum Zone	Arca montereyana, California	San Pablo	Santa Margarita	Etchegoin
Epitonium rugiferum Dall		×													
Epitonium washingtonensis Weaver		×	×												
Endoltium petrosum (Conrad)								×							
Eulima smithi Reagan					××										
Eulima washingtoniana Reagan															
Exilia dickersoni Weaver	×				×		×								
Fusinus montesanoensis Weaver															
Fusinus stanfordensis (Arnold)				×	×			×							
Fusinus corpulentus (Conrad)			×							×					
Fusinus coosensis Dall					×						×				
Drillia hecoxi (Arnold)	×	×													
Ficus chehalisensis Weaver				××											
Ficus wynoochensis Weaver															
Ficus oregonensis Conrad			×	×				×							
Ficus clallamensis Weaver															
Gyrineum sylvianensis Weaver					××										
Gyrineum mediocre corbiculatum Dall										×					
Hemifusus washingtoniana Weaver					×		×			×	×				
Liomesus sulcatus Dall	×							××							
Molophorus gabbi Dall	×	×								××	×				
Mioplecona indurata Conrad			×	×××	×			×							
Nassa andersoni Weaver												×			
Nassa arnoldi Anderson						×		×		××					
Natica oregonensis Conrad			×								×				
Olivella pedroana Conrad					×	×									
Polynices lewisii (Gould)	×		×				×	×		×					
Polynices galianoi Dall															
Polynices saxea Conrad			×	×	×							×			
Polynices clausa B & S															
Polynices olyphili Reagan	×		×												
Polynices lincolnensis Weaver										×					
Phalium aequisulcatum Dall	×			××	×										
Pisania clallamensis Reagan															
Ranella, n. sp.					××										
Ranella marshalli Reagan															

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POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON—(Cont.)

	Molopophorus lincolnensis Zone	Turritella porterensis Zone	Acila gettysburgensis Zone	Area montereyana Zone	Yoldia stigata Zone	Recent	Tejon formation of Washington	Astoria	Tunnel Point Beds	Rampire	Agasoma gravidum Zone	Area montereyana, California	San Pablo	Santa Margarita	Etchegoin
Scaphander oregonensis Dall				×	×					×					
Surcula lincolnensis Weaver	×														
Strepsidura oregonensis Dall	×														
Strepsidura lincolnensis Weaver	×														
Sinum scopulosum (Conrad)				×	×			×		×					
Thais etchegoinensis Arnold					×					×	×				×
Turris coosensis Dall					×					×					
Turris coli Dall					×					×					
Turris cammani Dall					×					×					
Turris fresnoensis Arnold	×	×			×					×					
Turris perversa Gabb				×											
Turris wynoochensis Weaver															
Turricula washingtoniana Dall			×					×			×				
Turritella oregonensis Conrad		×	×												
Turritella portersensis Weaver															
Turritella blakeleyensis Weaver			×												
Turritella newcombi Merriam			×												
CEPHALOPODA															
Aturia angustata Conrad	×	×	×	×				×	×						
ECHINODERMATA															
Scutella gabbi Rémond					×								×		
BRACHIOPODA															
Terebratula oahuiliensis Weaver		×													
Terebratalia occidentalis Dall			×												
Hemithyris astoriana Dall								×							
CRUSTACEA															
Brachyuran remains		×	×												
PROTOZOA															
Foraminifera	×	×	×												
PISCES															
Teeth	×	×	×												

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III

THE OLIGOCENE OF KITSAP COUNTY, WASHINGTON

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INTRODUCTION

The purpose of this paper is to place upon record the results obtained from geologic and paleontologic studies made in Kitsap County, Washington, along the north and south shores of the entrance to the Bremerton Navy Yard. Because of the isolated occurrence of pre-glacial outcrops, it seems desirable to select small areas of importance and to investigate the geology of them in as much detail as possible. The area involved in this study is located six miles west of Seattle and is of special importance because of the occurrence there of the most complete and representative section of the Oligocene within the Puget Sound basin. With the exception of the exposures along the south side of the Strait of Juan de Fuca, it is the most complete within the state.

The surface rocks in the larger portion of the Puget Sound basin are composed of deposits of glacial drift. In a number of small and isolated areas the older pre-glacial bedrock formations project up through the drift. Such exposures are usually found in the form of low sea cliffs or in the canyons of certain streams. The region under investigation is one of such areas.

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PREVIOUS INVESTIGATIONS

At various times during the last 10 years reference has been made in the literature on west coast Geology to the presence of Oligocene and Miocene fossils at Restoration and Beans points on the north shores of Richs Passage. In 1904 Dr. Ralph Arnold, in his paper on the Tertiary and Quaternary Pectens of California, refers to certain "shales near Beans Point, King County[1]," which contain a fauna of probable Oligocene age. Note is made concerning the occurrence of *Pecten peckhami* Gabb at U. S. G. S. localities 4112a and 4113, between Beans and Restoration points, King County. *Pecten clallamensis* Arnold is noted at Beans Point and "is associated with *Terebratula,* sp., *Turritella,* sp., *Marginella* or *Erato,* sp., *Natica* or *Lunatia,* sp., *Glycimeris,* sp., and *Astyris,* sp."

In 1909, Dr. W. H. Dall[2], in his paper on the Miocene of Astoria and Coos Bay, Oregon, mentions the occurrence of Oligocene strata at Port Blakeley and Restoration Point, opposite Seattle. The following species are listed from these localities: *Ampullina mississippiensis* Conrad, *Miopleiona indurata* Conrad, *Turcicula washingtoniana* Dall and *Aturia angustata* Conrad.

In 1911, the writer[3] in a preliminary paper on the Tertiary Palaeontology of Western Washington described the occurrence of lower Miocene strata and fossils in the Restoration Point and Blakeley Harbor area and provisionally referred to them as the Blakeley formation. These strata were recognized as a part of an extensive lower Miocene series involved in the north flank of a well-defined anticline trending from east to west across the Puget Sound basin.

The most recent report involving a discussion of the Restoration Point area is to be found in a paper by Arnold and Hannibal[4] on the Marine Stratigraphy of the North Pacific Coast of America, published in 1913. A three-fold division of the Oligocene is recognized: The San Lorenzo or lower, the

[1]Arnold, Ralph, The Tertiary and Quaternary Pectens of California. Professional Paper 47, U. S. Geological Survey, 1906.
[2]Dall, Dr. W. H., The Miocene of Astoria and Coos Bay, Oregon. Professional Paper 59, U. S. Geological Survey, 1906.
[3]Weaver, C. E., A Preliminary Report on the Tertiary Palaeontology of Western Washington. Bull. 13, Wash. State Geol. Surv., 1912.
[4]Arnold, Ralph, and Hannibal, Harold, The Marine Tertiary Stratigraphy of the North Pacific Coast of America, Proc. Am. Phil. Soc., vol. 52, pp. 573-579, 1913.

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Seattle or middle, and the Twin River or upper. The lower and middle divisions are stated to occur at Restoration Point. The San Lorenzo formation is described as the "sandstones overlying the lower Astoria basalts west of Port Orchard Sound and forming the lower half of the Bainbridge Island section of the Seattle monocline." The Seattle formation is said to consist "of the upper beds of the northward dipping Seattle monocline extending from Restoration Point on Bainbridge Island across Admiralty Inlet." The Twin River formation is not believed to occur in the Puget Sound basin.

In none of the investigations so far undertaken has an attempt been made to work out the details of the stratigraphy.

GENERAL STATEMENT CONCERNING THE MARINE TERTIARY IN WESTERN WASHINGTON*

All of the pre-glacial areal outcrops in the western part of the state with the exception of the central and western portions of the Olympic Peninsula and the San Juan Islands are of Tertiary age. Both sedimentary and igneous rocks are present. They were formed during the Eocene, Oligocene and Miocene epochs. With the exception of possible marine sediments in the extreme western portion of Chehalis County, no rocks of definite Pliocene age are known to exist. The history of the Pliocene in western Washington must be sought in terms of diastrophism and erosion.

During the Eocene epoch there were formed deposits of marine, brackish and freshwater origin. Intercalated with these are lavas and tuff of andesitic character. These deposits attain a total maximum aggregate thickness of at least 10,000 feet. The marine invertebrate faunas occurring within these strata indicate that only the Tejon or upper Eocene is present in western Washington.

Five distinct marine faunal zones can be recognized in the post-Eocene formations of western Washington:

Yoldia strigata zone.....Upper Miocene
Arca montereyana zone.....Lower Miocene

*A detailed report on the "Tertiary Formations of Western Washington" by the writer will be issued as a bulletin of the publications of the Washington State Geological Survey. Accompanying this report are detailed areal and structural geological maps of the western portion of the state.

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Acila gettysburgensis zone.....Upper Oligocene
Turritella porterensis zone.....Middle Oligocene
Molopophorus lincolnensis zone.....Lower Oligocene

The strata in which these zones are contained are referred to in this paper as horizons, the term being used in the sense of a deposit formed during a certain time and identified by certain distinctive fossils.

The type locality for the Molopophorus lincolnensis zone occurs along the south bank of Chehalis River near the mouth of Lincoln Creek. This fauna possesses many characteristics in common with the underlying Tejon Eocene, but more with the Turritella porterensis zone above. The strata characterized by this fauna may be referred to as the Lincoln horizon.*

The Turritella porterensis zone is to be found well represented in the sandstone bluffs along the north bank of Chehalis River near the junction of Porter Creek. The sediments containing this fauna have been referred to as the Porter horizon. Among the more characteristic fossils occurring in this fauna are *Phacoides acutilineatus* (Conrad), *Thyasira bisecta* (Conrad), *Thracia trapezoidea* Conrad, *Cardium lorenzanum* (Arnold), *Turritella porterensis* Weaver, *Drillia stanfordensis* (Arnold) and *Malletia chehalisensis* Arnold. It is possible that the upper portion of this zone may be represented in the extreme lower portion of the section at Orchard Point.

The type section of the third or Acila gettysburgensis zone occurs within the strata exposed near the entrance to the Bremerton Navy Yard. Most of the faunas from the post-Tejon and pre-glacial strata in the Puget Sound basin belong to this zone. The sandstones and shales containing the fauna form the Blakeley horizon.

The fourth division, or Arca montereyana zone, is to be found in the sandstones outcropping along Alockaman River in Wahkiakum County, 12 miles north of Cathlamet. It also occurs in the sandstone and shale exposures along the south

*There is considerable doubt in the writer's mind as to the wisdom of using the term, horizon. In geological literature it is often used in a very loose sense. Sufficient geological field evidence is not available to warrant the term formation as yet. Without the introduction of an entirely new word to express the idea of an assemblage of varying types of rocks all of which are characterized by the same distinctive fauna, it becomes necessary to choose one which has been used most nearly in such a sense.

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shore of the Strait of Juan de Fuca between Pysht and Clallam Bay. The strata are referred to as the Wahkiakum horizon.

Resting unconformably upon the Oligocene and lower Miocene sediments are shallow water deposits of upper Miocene age containing a distinctive fauna which may be referred to as the Yoldia strigata zone, or Montesano horizon.

STRATIGRAPHY

From the western spur of the Cascade Mountains in King County, a prominent spur extends nearly due west into the Puget Sound basin. This spur includes the Issaquah and Newcastle hills. From Lake Washington it trends westerly through Seattle as a pre-glacial and, in part, submarine topographic feature. It crosses the Sound a little to the south of Bainbridge Island and reappears in the Bald Hills of central Kitsap County. Structurally this ridge is of anticlinal origin. Sedimentary and volcanic rocks of Eocene and Oligocene age are involved within it. Extensive erosion has deeply cut into it so that the Oligocene strata have been completely removed from the axis. The core is largely composed of Eocene basalts together with brackish water and marine sediments. The coal measures at Issaquah and Newcastle, together with the sandstone and shales between Duwamish and Renton, belong to this phase. The basalts which outcrop on the shores of Sinclair Inlet, as well as those southwest of Bremerton in the Bald Hills, belong to the basaltic phase of the Tejon-Eocene. Resting unconformably upon the Eocene rocks and forming a part of the north flank of the anticline just mentioned, are sandstone and shales of Oligocene age. These strata are exposed in the north slopes of the Newcastle Hills, in the street cuts of Columbia City and Georgetown (both of which are within the city limits of Seattle), along the shores of Bailey Peninsula and at Alki Point. West from Seattle they outcrop at the water's edge at the south end of Bainbridge Island and along the south shores of Richs Passage. They appear for a distance of a mile along both shores of the narrow channel northwest of Bremerton near Tracyton. To the north of these Oligocene outcrops, the only formations within the county exposed at the

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surface are deposits of glacial drift. Presumably they are involved in a broad synclinal basin beneath the glacial drift of northern Kitsap County. The evidence for such a suggestion is to be found to the northwest on the Quimper Peninsula between Quilcene and Port Townsend. In that region the same Oligocene strata resting unconformably upon the Eocene basalts exist in a broad synclinal fold whose axis trends southeasterly and passes beneath the glacial covering of northern Kitsap County. It can be seen from the foregoing statements that the Oligocene beds exposed at the entrance to the Bremerton Navy Yard are a representative part of the Oligocene formations of the Puget Sound basin and as such are worthy of detailed study.

In the investigation of this particular region transit surveys were made along the shore lines wherever pre-glacial formations were exposed. All observations taken on the strike and dip of the strata were tied in to these traverses. Stratigraphic sections were also made with the aid of the transit. The distribution of the Oligocene strata as exposed along the shore lines, as well as the structural data, may be seen by referring to Fig. 1.

The Oligocene strata of this region are entirely of sedimentary origin. The Eocene lavas upon which these sediments rest are exposed about two miles southwest of Bremerton on the west shore of Sinclair Inlet. The position on the surface of the contact between the Eocene andesites and the Oligocene sediments in this region is concealed beneath deposits of glacial drift. Many of the pebbles forming the basal conglomeratic phases of the Oligocene strata are composed in part of the older andesite.

The lowermost strata exposed in this area outcrop at Orchard Point. The highest occur along the north shore of the entrance to Blakeley Harbor. The total thickness of the deposits as exposed between the lower and uppermost beds is approximately 8900 feet. The following generalized stratigraphic column is constructed from observations taken along the section (B-B'):

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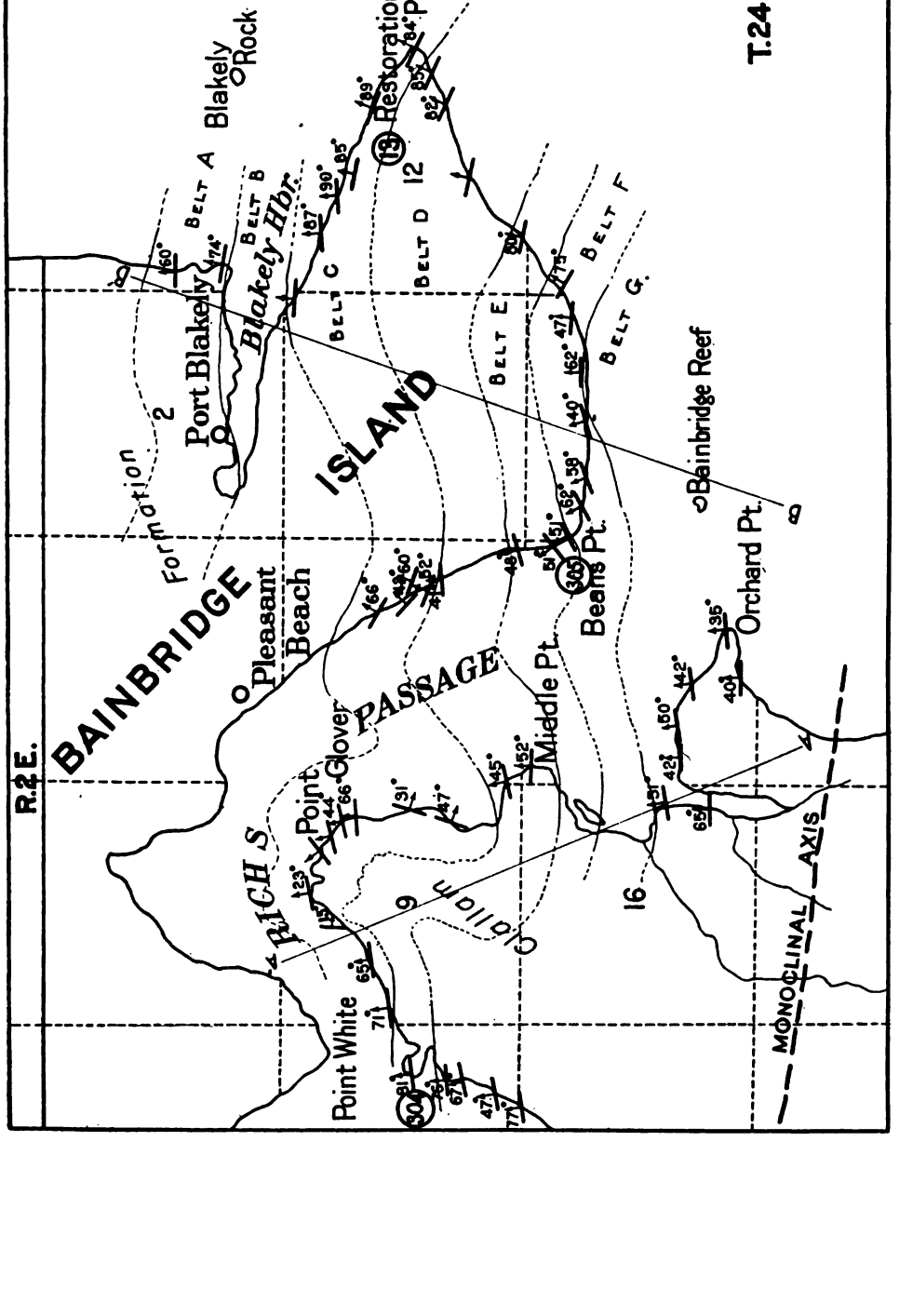

Figure 1: Sketch Map showing structural conditions in the vicinity of Port Blakeley.

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Top of Section

	Feet
Massive, coarse-grained conglomeratic sandstones containing numerous lenticular bands of conglomerate. Occasional narrow bands of clay shale are interbedded. The eastward continuation of the conglomerates appears in the outcrops at Blakeley Rocks. These strata persistently pitch to the north at very steep angles and extend as outcrops from the north shore of Blakeley Harbor northerly for 1500 feet....	1,300 (A)
Sandy shales exposed beneath the waters of Blakeley Harbor..	1,400 (B)
Brownish gray, massive to slightly bedded, sandy shales as exposed along the south shore of Blakeley Harbor for a distance of one-half mile northwesterly. Five hundred feet stratigraphically above the beds exposed at Restoration Point is an excellent fossil locality, No. 13.....	2,400 (C)
Shaly sandstone grading in places into a sandy shale. Bedding planes are commonly well defined. The top of this belt is located at Restoration Point.....	1,200 (D)
Shaly sandstone gradually becoming more sandy in depth. Bedding planes, very distinct.....	450 (E)
Massive, sandy shales. Bedding planes, fairly distinct. Fossil locality No. 305.....	350 (F)
Massive, brownish gray, coarse-grained conglomeratic sandstones with interbedded bands of coarse conglomerate, the pebbles of which attain a diameter of two feet. Many of the pebbles are composed of andesite and others of light colored shale and sandstone	1,800 (G)
Total thickness	8,900

The westerly continuation of the strata as exposed in the above section reappears in cross-section A A'. The upper beds as exposed at Point Glover appear to be the equivalent of those in belt (C). The extreme upper portion of belt (G) as exposed at Orchard Point is the westerly continuation of the narrow conglomeratic layers occurring just east of Beans Point on the south end of Bainbridge Island. The conglomerates outcropping at Quarry Point are the equivalent of those exposed at Middle Point. From Middle Point they cross Richs Passage and appear in the cliffs at Fort Ward on the south shore of Bainbridge Island. At this point they become less conglomeratic and more sandy. Near Restoration Point they are the equivalent of the upper portion of belt (D). The shales and sandstones exposed between Point Glover and Middle Point are to be correlated with the sandy shales in belt

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(C). The conglomerates in belt (A) and the shales in belt (B) do not appear on the south side of Richs Passage. It is possible, however, that the conglomeratic sandstones and interbedded shales near Tracyton and Phinney Point are the equivalents of those in belts (A) and (B). The following stratigraphic section has been measured between the basal beds at Orchard Point and the higher beds exposed at Point Glover along section (A A'):

Top of Section at Point Glover	Feet
Massive, sandy shale with poorly defined bedding planes	150
Shaly sandstone	70
Brownish gray, sandy, clay shale	500
Massive, brown sandstone	100
Gray, sandy shale	45
Brown, massive, coarse-grained sandstone	60
Interbedded shale and sandstone, shale predominating	140
Massive sandstone	80
Thickly bedded shale	200
Alternating beds of thinly bedded shales and sandstones	520
Banded sandstone and shale, shale predominating	40
Banded shale and sandstone, shale predominating	20
Thinly bedded, gray shale	70
Massive, brownish gray sandstone	40
Thinly bedded shale	30
Massive, brown sandstone	300
Mainly shale with a few narrow bands of sandstone	200
Mainly sandstone with a few narrow bands of shale interbedded.	30
Mainly thin bedded, clay shale without distinct bedding	900
Massive, brown sandstone	65
Alternating layers of thinly bedded sandstones and shale with occasional bands of sandstones four to five feet in thickness	90
Massive, brown sandstone, slightly banded	75
Banded shale	10
Thinly bedded shaly sandstone	40
Alternating bands of thinly bedded shale and sandstone	75
Massive, brown sandstone	20
Massive, brown gritty sandstone	35
Gray shale possessing well-defined bedding	100
Massive, brown sandstone containing bands of shale	30
Mostly shale with a few bands of interbedded sandstone. Strata in part concealed	1,800
Thinly bedded shale somewhat massive in places and containing occasional bands of sandstones averaging one foot in thickness	320
Massive, brownish gray sandstone containing pebbly and conglomeratic bands	1,400
Massive conglomerates composed of pebbles ranging up to two feet in diameter and composed in part of altered andesite	15
Massive, gritty sandstone	60
Conglomerate	15
Massive, gritty brown sandstone. These are the lowest strata exposed in the Bremerton Inlet area	70
Total thickness	8,715

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FAUNAL RELATIONS

The invertebrate fauna occurring in the sedimentary rocks just described is entirely of marine origin. Altogether 42 species are present. In the lower beds outcropping at Orchard Point and represented by belt (G), the only species found are *Cardium lorenzanum* (Arnold), *Nucula,* sp., and *Tellina oregonensis* Conrad. In the following table the fauna listed from locality No. 13, comes from the sandy shales north of Restoration Point in belt (C). Locality No. 304 is located at the west end of Quarry Point and the fauna occurring there belongs to belt (C). Locality No. 305 occurs at Beans Point in the lower portion of belt (F).

The most characteristic species occurring in this region are *Acila gettysburgensis* Reagan, *Macrocallista vespertina* (Conrad), *Marcia oregonensis* (Conrad), *Modiolus inflatus* Dall, *Panope generosa* (Gould), *Phacoides acutilineatus* (Conrad), *Solemya ventricostata* Conrad, *Thracia trapezoidea* Conrad, *Eudolium petrosum* Conrad and *Turcicula washingtoniana* Dall. The most fossiliferous portion of the formation is in belt (C). The fauna occurring in belt (F) except in the number of species does not differ greatly from that in belt (C). The conglomerates and coarse-grained sandstones composing the lowermost beds of the section as exposed at Orchard Point is almost entirely barren of fossils. This lower belt may correspond to the upper part of the Porter horizon or Turritella porterensis zone as exposed in the Chehalis Valley.

The fauna appearing in belt (C) at Restoration Point is almost identical with that occurring to the east within the city of Seattle, and in the sandy shales on the north slopes of the Newcastle Hills. It may also be correlated with that at Fiddlers Bluff about two miles south of the town of Snohomish. The shales and sandy shales outcropping between Pysht and Gettysburg are also to be referred to this horizon or faunal zone. The following table gives the distribution of the marine fauna occurring in the Bremerton Inlet area:

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Faunal List

	13	304	305
Acila gettysburgensis Reagan	*	*	*
Arca, sp.	*		
Cardium lorenzanum (Arnold)	*	*	*
Chione cathcartensis Weaver	*		
Crenella porterensis Weaver	*		*
Leda chehalisensis Weaver	*		
Macrocallista vespertina (Conrad)	*	*	*
Marcia oregonensis (Conrad)	*	*	
Modiolus directus Dall	*	*	
Modiolus inflatus Dall	*		
Mytilus sammammishensis Weaver	*		
Nucula conradi Meek	*		*
Ostraea, sp.		*	
Panope generosa (Gould)	*	*	*
Pecten peckhami Gabb	*		
Pecten, sp.			
Phacoides acutilineatus (Conrad)	*	*	
Solen curtus Conrad	*	*	*
Solemya ventricostata Conrad	*	*	*
Spisula albaria (Conrad)	*	*	
Tellina obruta Conrad	*	*	*
Tellina oregonensis Conrad	*		
Thracia trapezoidea Conrad	*	*	
Thyasira bisecta Conrad	*	*	
Yoldia impressa Conrad	*	*	
Yoldia oregona Shum	*		
GASTEROPODA			
Ampullina oregonensis Dall	*		
Crepidula praerupta Conrad	*	*	
Epitonium, sp.	*		
Eudolium petrosum (Conrad)	*	*	
Fusinus, sp.	*	*	
Miopleiona indurata (Conrad)	*	*	
Natica oregonensis Conrad	*	*	
Scaphander oregonensis Dall	*	*	*
Turcicula washingtoniana Dall	*	*	
Turritella blakeleyensis Weaver	*		
Turritella newcombi Merriam	*		
Turris fresnoensis (Arnold)	*		
SCAPHOPODA			
Dentalium conradi Dall	*	*	*
CEPHALOPODA			
Aturia angustata Conrad	*		*
BRACHIOPODA			
Hemithyris astoriana Dall	*	*	*

CONDITIONS OF DEPOSITION

At the close of the Tejon epoch the Eocene deposits were differentially uplifted. Early in the Oligocene new embayments were formed. The seas of the northern part of the

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Puget Sound region were disconnected from those to the south in the Grays Harbor area. The shore line of the present site of the Puget Sound embayment appears to have existed somewhere between Seattle and Tacoma and to have extended in an east to west direction from the present site of the Cascade Mountains to the present location of the Olympics. The present contact between the Eocene and Oligocene formations in the Bremerton Inlet, or Kitsap County, area is much farther north than the original southerly limits of the shore line. The strata have been tilted from their original horizontal position into a nearly vertical position and as a result those sediments which formerly extended to the south have been entirely removed by erosion. The lithologic character of the sediments and the faunas occurring within them indicate that they were deposited in shallow to moderately deep water. No products of direct volcanic origin were poured out in this region during the Oligocene epoch. This is in sharp contrast to the conditions of volcanic activity during the Tejon.

CONCLUSIONS

The area involved in this investigation is of special importance because within it occurs one of the most complete sections of Oligocene strata to be found in the state. There are approximately 8900 feet of conglomerates, shales and sandstones which are entirely of marine origin and rest unconformably upon older Tejon basalts and sediments. The contact in this area between the Tejon and Oligocene is obscured by deposits of glacial drift. The Oligocene strata form the north flank of an extensive east to west trending anticline, the axis of which has been deeply dissected by erosion. A marine fauna of 44 invertebrates is now known. The horizon represented is upper Oligocene. The fauna is a unit from base to top of section and is termed the Acila gettysburgensis zone.

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V

MONOGRAPH OF THE NORTH AMERICAN SPECIES OF ORTHOTYLUS (HEMIPTERA)

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Genus **Orthotylus** Fieb.

In common with other genera of its tribe, the genus *Orthotylus* has the apical margin of the pronotum without a collar; the prosternal xyphus (the triangular plate between the anterior coxæ) with a more or less distinctly carinate margin, its base being flat or convex, and the arolia (the pulvillæ between the tarsal claws) free and converging toward their apex. The following are the more essential characters of this genus:

Head almost vertical; when viewed from above, short, transverse, with the eyes distinctly wider than the anterior margin of the pronotum; when viewed from before, five-angled, but little longer than wide across the eyes. Vertex with a basal carina and before it a depressed line or area. Front convex; clypeus prominent, its base usually on a line with the base of the antennæ. Facial angle (angle between the line of the clypeus and that of the bucculæ) a right angle. Eyes prominent, viewed from the side ovate, placed a little oblique or

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nearly vertical; when viewed from above nearly round or more or less flattened within. Antennæ pubescent, inserted near or somewhat below the lower angle of the eyes; linear; basal joint thickest, the apical becoming setaceous; the basal joint with two or three longer stiff bristles or setæ within toward its apex. Pronotum trapezoidal, rather flat, usually transverse, but sometimes nearly or quite as long as broad, its converging sides nearly rectilinear and its base feebly arcuated or straight across the scutellum; callosities prominent, usually distant but often connected by an elevated area anteriorly that does not reach their hind margin. Scutellum nearly flat or moderately elevated, its basal lobe often more or less exposed. Elytra normally rather long, considerably surpassing the abdomen. Membrane biareolate. Legs rather long, the hind femora moderately incrassate; tibiæ armed with a few weak spines. Rostrum normally attaining the apex of the intermediate coxæ, becoming black at apex. Oviduct of female short, beginning behind the middle of the venter. Upper surface usually clothed with a fine pubescence or with longer and stiffer hairs, or with both.

Our species of this large and difficult genus may conveniently be grouped in three series:

Group I (*flavosparsus* group). Small, moderately elongated green species with the base of the vertex sharply carinate, the pronotum short, transverse, and the legs comparatively short. Some of the species are clothed with coarse, often flattened, deciduous black hairs. Here belong: *insignis,* n. sp.; *tibialis,* n. sp.; *ferox,* n. sp.; *viridicatus* Uhl.; *coagulatus* Uhl.; *flavosparsus* Sahlbg.; *chlorionis* Say; *fraternus,* n. sp.; *uniformis,* n. sp.; *translucens* Tuck.; *viridis,* n. sp.; *senectus,* n. sp.; *nigrinasi,* n. sp.

Group II (*ovatus* group). Medium sized, oval, pale colored species having much the form of a *Lygus* with the aspect of an *Oncotylus.* These have the base of the vertex obtusely carinate, the pronotum transverse and the legs comparatively short. Here belong *ovatus,* n. sp., and *catulus,* n. sp.

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Group III (*dorsalis* group). More elongated or slender species having the base of the vertex sharply carinate preceded by a distinct bidentate transverse depression; the pronotum nearly or quite as long as broad and the legs long and slender. The species of this group are usually pale, marked more or less with fuscous or black, the elytra typically having the clavus and an area on the disk of the corium fuscous or black. Here belong: *formosus,* n. sp.; *modestus,* n. sp.; *dorsalis* Prov.; *marginatus* Uhl.; *molliculus,* n. sp.; *affinis,* n. sp.; *angulatus* Uhl.; *brunneus,* n. subsp.; *cuneatus,* n. sp.; *pullatus,* n. sp.; *languidus,* n. sp.; *lateralis,* n. sp.; *cruciatus,* n. sp.; *submarginatus* Say; *necopinus,* n. sp.; *fumidus,* n. sp.; *ornatus,* n. sp.; *candidatus,* n. sp.

I have been unable to locate *inconspicuus* Uhl. Reuter's description of his *biguttatus* answers almost perfectly to *coagulatus* Uhl. of which it probably is a synonym. Tucker records *diaphanus* Kirschb. from Kansas, but the determination is very doubtful. The present paper includes all other species recorded from America north of Mexico. The following key will locate our species:

Ground color green, sometimes almost white, dark markings if present not clouding the elytra .....1.
Ground color pale testaceous to black, sometimes greenish when immature; the elytra in that case marked with fuscous or black areas....14
1, Antennæ, tibiæ and tarsi black; ground color a bluish-green; small species (3mm. to tip of abdomen),.....2. *tibialis,* n. sp.
—, Antennæ pale or mostly so,.....2.
2, Basal joint of the antennæ marked with black,.....3.
—, Basal joint of the antennæ uniformly pale,.....4.
3, Antennæ slightly infuscated, the basal joint green or greenish with its immediate base deep black, ...1. *insignis,* n. sp.
—, Antennæ pale; basal joint biannulate with black; base and apex of second joint fuscous; apex of the head deep black..13. *nigrinasi,* n. sp.
4, Form broader or ovate, somewhat like a small *Lygus,*.....5.
—, Form more slender and parallel,.....6.
5, Color a yellowish-green, with the membrane infuscated; the surface clothed with deciduous matted fuscous hairs.....14. *ovatus,* n. sp.
—, Color nearly white; above sparsely dotted with bluish-green in mature examples, ...11. *senectus,* n. sp.
6, Membrane black or blackish with the nervures calloused and white at apex; surface clothed with coarse deciduous black hairs,.....
.....4. *viridicatus* Uhl.
—, Membrane sometimes infuscated, the nervures then pale or concolorous, ...7.

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7, Membrane infuscated at apex, marked with a distinct white spot at tip of the cuneus followed by a blackish cloud and beyond that a pale vitta, sometimes obsolete,.....5. *coagulatus* Uhl.
—, Membrane without alternating black and white markings at tip of the cuneus, ...8.
8, Upper surface with minute pale pubescence; apical antennal joints infuscated, ...9.
—, Upper surface with dark fuscous or black pubescence,.....11.
9. Smaller (4-4½mm.); first antennal joint thicker, obviously shorter than the head viewed from above; sinistral hook of the male genitalia short, scarcely longer than the dextral,.....10. *translucens* Tuck.
—, Larger (5-5½mm.); first antennal joint obviously as long as the head, ...10.
10, Basal joint of the antennæ fulvo-testaceous like the second joint; dextral hook of the male genitalia small, ligulate; sinistral long, curved and acuminate; western, ...9. *uniformis*, n. sp.
—, Basal joint of the antennæ brown, the second fulvo-testaceous; dextral hook of the male genitalia large and broad-triangular; sinistral linear and straight, rather long; eastern,.....12. *viridis*, n. sp.
11, Elytra surpassing the abdomen by nearly one-half its length; abdomen in the male reaching to just beyond the base of the cuneus; antennæ and membrane slightly infuscated,.....8. *fraternus*, n. sp.
—, Elytra shorter, the abdomen of the male reaching well toward the apex of the cuneus, ...12.
12, Upper surface clothed with deciduous black hairs which are in part flattened and conspicuous; color pale bluish-green; vertex broadly depressed, ...3. *ferox*, n. sp.
—, Upper surface clothed with a less conspicuous vestiture, the hairs not large and flattened; color a yellowish-green; transverse basal depression of the vertex narrow, ...13.
13, Areoles of the membrane pale green; elytra with clusters of white hairs intermixed with dark ones,.....6. *flavosparsus* Sahlbg.
—, Areoles of the membrane concolorous; elytra without pale hairs intermixed with the dark ones,.....7. *chlorionis* Say.
14, Form ovate as in *Lygus campestris* nearly; color a uniform whitish of fusco-testaceous, head and callosities tinged with yellowish,.....
.....15. *catulus*, n. sp.
—, More elongated species; elytra with fuscous areas more or less marked, or at times entirely black,.....15.
15, Color whitish-testaceous, fuscous markings of the elytra very faint or nearly obsolete in the female,.....16.
—, Ground color sometimes pale greenish or yellowish, the dark elytral markings always distinct, or the whole insect may become almost black, ...17.
16 ,Without black markings, the disk of the head and the pronotum behind the callosities sometimes with a faint fuscous cloud in the male; membrane with a faint ray beyond the areole; antennæ pale,.....
.....16. *languidus*, n. sp.
—, Median line of the front, vertex and scutellum, lateral margins of the pronotum and the sides of the body beneath black; membrane slightly infuscated with the nervure brown; antennæ blackish,.....
.....32. *candidatus*, n. p.
17, Body uniformly fuscous, the sides of the venter darker; length 6mm., ...34. *fumidus*, n. sp.
—, Body never uniformly fuscous, the elytra with at least the costal nervure or a vitta interior to it pale,.....18.
18, Elytra with the costal and commissural nervures and base of the cuneus slenderly pale, otherwise fuscous-brown above; length 7mm.,.....
.....33. *necopinus*, n. sp.

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—, Elytra with more than the costal and commissural nervures pale; length under 6mm., ...19.
19, Costal nervure black with a pale vitta between it and the dark dorsal vitta, or it may be dark on the dark areas without a pale vitta interior to it, ...31.
—, Costal nervure pale and forming part of a pale costal vitta,.....20.
20, Disk of the pronotum pale with the lateral margins covered by a linear black vitta, the pale disk narrowing anteriorly,.....29.
—, Disk of the pronotum sometimes with a broad pale median vitta, but then with the humeral angles and usually the sides pale,.....21.
21, Pronotum with the anterior lobe infuscated, the posterior lobe more or less distinctly pale, usually divided by a dark median vitta,.....30.
—, Pronotum with the anterior lobe usually pale, never infuscated with the disk of the posterior lobe pale,.....22.
22, Membrane vittate, more or less hyaline with a darker ray beyond the areole, ...23.
—, Membrane uniformly infuscated, without a darker ray beyond the areole, ...24.
23, Areole of the membrane hyaline, the vitta beyond the areole evident; color of body clear pale green with a line on the hind margin of the pronotum and a spot behind the callosities black; a vitta on the clavus and spot near the inner angle of the corium fuscous,.....
.....17. *formosus*, n. sp.
—, Areole of the membrane more deeply infuscated than the adjoining surface, body more or less infuscated, the base of the corium, the cuneus and usually the median line of the pronotum pale,.....
.....30. *ornatus*, n. sp.
24, Nearly the whole surface including the legs black or blackish, the costal margin, ventral vitta, coxæ and trochanters only pale,.....
.....26. *pullatus*, n. sp.
—, The legs, at least, pale or but little infuscated,.....25.
25, Callosities pale or they are the last portion of the pronotum to become invaded with black; vertex often black, when pale without a transverse black mark on either side,.....26.
—, Callosities black or they are the first part of the pronotum to become invaded with black; vertex pale with a transverse black mark on either side, ...28.
26, Antennæ black in both sexes; genital hooks of the male pale; the male generally with a pale dorsal vitta on the pronotum, 20. *marginatus* Uhl.
—, Antennæ pale in the female, fuscous or black in the male; genital hooks of the male black,.....27.
27, Pronotal markings transverse; when the pronotum is all black the second antennal joint of the male is rufo-testaceous, 18. *modestus*, n. sp.
—, Pronotal markings longitudinal; when the pronotum is all black the second antennal joint of the male is black,.....19. *dorsalis* Prov.
28, Smaller (5mm.); body beneath mostly black; front black or mostly so, ...21. *molliculus*, n. sp.
—, Larger (6mm.); body beneath mostly pale; front pale with a black arc either side, ...22. *affinis*, n. sp.
29, Smaller (4mm.); second antennal joint short, not longer than the third and fourth together, ...28. *lateralis*, n. sp.
—, Larger (5mm.); second antennal joint long, distinctly longer than the third and fourth together,.....27. *cruciatus*, n. sp.
30, Sutural margin of the corium with a wedge-shaped pale mark,.....
.....23. *angulatus* Uhl.
—, Sutural margin of the corium with a linear pale mark,.....
.....24. *angulatus brunneus*, n. subsp.

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31, Costal nervure concolorous, dark against the dark areas; elytra blackish, the base of the cuneus and a wedge-shaped mark along the claval suture pale, ...25. *cuneatus*, n. sp.
—, Costal nervure black with a pale vitta between it and the black dorsal vitta, ...32.
32, Ground color above fulvous or salmon, elytra black, the fulvous border of the corium not attaining the costa, the extreme edge being black,.....31. *submarginatus* Say.
—, Elytra black with a subcostal whitish vitta covering most of the cuneus; posterior disk of the pronotum and the legs fulvous,.....
.....29. *knighti*, n. sp.

Group I (Subgenus *Orthotylus* Fieb.)

1. **Orthotylus insignis**, new species.

Larger and more slender than any allied species; elongated or elliptical; bright grass-green becoming yellowish about the head and base of the femora; first joint of the antennæ yellowish with its immediate base conspicuously black, length 5-6mm., width 1½mm.

Vertex much depressed posteriorly, leaving the basal carina strongly elevated; front but moderately convex. Eyes prominent, viewed from the side shorter than in the allied forms. Antennæ unusually long, about reaching to the apex of the membrane; basal joint longer than the head in the female, much longer in the male; second joint two and a half times the length of the first; third about two-thirds the length of the second; fourth shorter than the first. Rostrum short, not attaining the apex of the intermediate coxæ. Pronotum short, flat, showing a median carina and lateral carinate margins; deeply impressed around the prominent callosities, thus making the anterior margin appear thickened; sides strongly oblique, the anterior angles broadly rounded. Elytra long, elliptical in the female, the tip of the cuneus scarcely surpassing the tip of the abdomen; in the male nearly parallel, the costal margin very gently arcuated, the corium a little surpassing the tip of the abdomen. Legs unusually long and slender, the tibiæ with a few weak bristles.

Dextral hook of the male genitalia very large, recurved from near its base, where there is an acute projection from the inner angle, the upper member greatly produced in a long curved brown spine-like process almost attaining the opposite

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wall of the pygofers; sinistral hook long, white and terete, curved around horizontally concentric with the sinistral wall of the genital segment.

Color a clear bluish-green, becoming yellowish on the head, pronotum and beneath; clothed above with short, black, deciduous hairs; antennæ pale, the base of the first joint narrowly deep black, the apical joints infuscated. Elytra immaculate, the membrane with pale nervures. Tibiæ pale clothed with minute black hairs, the tarsi black.

Described from one male and two female examples taken by me at the upper end of Fallen Leaf Lake, Calif., July 24, 1915. This pretty species is unusually large and slender and in some points is not typical of this genus.

Type, male, in the collection of the University of California. Allotype (No. 301) in the Museum of the California Academy of Sciences. Paratype in collection of the University of California.

2. **Orthotylus tibialis**, new species.

Form of *Labopidea nigripes* nearly, but much smaller; bluish-green, conspicuously clothed with black deciduous hairs; antennæ, tibiæ, and tergum black. Length 4-4½mm. to tip of membrane.

Head large, vertical; eyes small, bead-like; viewed from the side, short, scarcely surpassing the insertion of the antennæ, narrowed below, little longer than broad. Vertex with a large triangular impressed area; basal carina prominent. Front strongly convex; clypeus small, prominent. Pronotum short, transverse, its length distinctly less than one-half its basal breadth; callosities prominent, elongated. Basal joint of the antennæ longer than the head, much thickened almost to the base; second about three times the length of the first. Elytra of the male long, the costa moderately arcuated, the apex of the abdomen reaching to the tip of the corium. Elytra of the female hardly attaining the apex of the abdomen, the costa well arcuated, giving the insect an ovate form, broadest beyond the tip of the clavus, the membrane but little surpassing the tip of the cuneus.

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Dextral hook of the male genitalia broad at base, upcurved and attenuated at apex; sinistral hook short and strap-shaped, lying along the edge of the pygofer.

Color dull bluish-green, conspicuously clothed with coarse black deciduous hairs. Head and lower surface paler. Antennæ, apex of the rostrum and the tibiæ and tarsi deep black; tergum black, becoming green toward the margin.

Described from numerous examples taken about the lower end of Fallen Leaf Lake, near Lake Tahoe, Calif., July, 1915. The conspicuously black tibiæ and antennæ will readily locate this distinct species.

Type, male, and allotype in collection of the University of California. Paratypes in collections of the Museum of California Academy of Sciences (nos. 302-304), University of California and in author's collection.

3. **Orthotylus ferox,** new species.

Form and size of *flavosparsus,* nearly; color a pale faded green, clothed with stout black hairs when fresh. Length 3½mm. to tip of membrane.

Head short, vertical. Eyes small; viewed from the side, vertical, but little longer than wide, narrowed to an angle below, not reaching much beyond the middle of the side of the head. Vertex broad, basal impression broad and shallow, the basal carina prominent, obtuse, sinuated. Front prominent, convex, its sutures deep; facial angle rounded. Antennæ short; first joint shorter than the dorsal aspect of the head. Pronotum short, transverse, its length about one-half its basal width; sides straight, the angles well rounded; anterior margin concavely sinuated; callosities prominent. Scutellum small, the basal lobe covered. Elytra moderately broad, the costa feebly arcuated. Abdomen passing the middle of the cuneus in the male, nearly attaining the apex in the female. Tibiæ with the longer bristles black. Whole upper surface clothed with coarse appressed black hairs, which are easily rubbed off.

Male genital characters much like those of *tibialis,* but the pieces are less curved and less interlocked; the dextral hook narrower and more acute; the sinistral lying close to the edge of the segment.

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Color pale bluish-green with a whitish aspect when denuded. Scutellum, head, lower surface and legs, and sometimes the callosities, yellowish. Membrane faintly fuliginous, the nervures paler. Antennæ infuscated nearly to the base of the second joint, the basal pale. Tibial bristles and apex of the tarsi black.

Described from numerous specimens taken in San Diego County, Calif., as follows: Alpine, March to April; Balboa Park, San Diego, April; El Cajon Valley, May first. This insect has much the aspect of *tibialis* and quite similar genital characters, but the females are less oval and the antennæ are pale instead of black. This and the three following species have the vertex broader with much smaller and less prominent eyes.

Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (305, 306), collection of the University of California and in author's collection.

4. **Orthotylus viridicatus** Uhler.

Form of *coagulatus;* clothed above with coarse black deciduous hairs; membrane blackish with the nervures at the apex of the areoles conspicuously white. Length 4½mm.

Head smaller than in the allied species with the eyes large and prominent, especially in the males. Vertex flat, distinctly, angularly impressed before the prominent basal carina; front but slightly convex. Clypeus very prominent, its base distinctly below the line of the antennæ. Eyes, viewed from the side, much longer than broad, angled below, reaching over halfway to the gula. Antennæ short, the second joint scarcely longer than the basal width of the pronotum. Pronotum short, transverse; sides scarcely arcuated, the anterior angles well rounded; callosities prominent, convex. Elytra rather short, the abdomen reaching to about the middle of the cuneus in the male, to beyond its tip in the female.

Dextral hook of the male genitalia long protruding, terete, its end rounded and not at all narrowed; sinistral hook broad, curved, parallel with the lower margin of the pygofers, its acute apex curved inward.

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Color, a bluish-green in mature examples, becoming yellowish on the callosities and head, and paler beneath; above clothed with deciduous pale hairs intermixed with thick black ones. Vertex and pronotum with a pale median line more or less apparent. Basal joint of the antennæ green, second darker, the third and fourth infuscated. Tibiæ a little darker, the apical half of the tarsi black. Membrane deeply infuscated, the nervures thickened and white below the base of the smaller areole.

The types of this species were from Colorado and New Mexico. I have seen specimens from Idaho and took it in abundance in San Diego County, Calif., during March, April and May, and it was not uncommon about Fallen Leaf Lake, Calif., at lower levels (between 6,000 and 7,000 feet). So far as I can now tell, my material was all taken on the sage brush, *Artemesia,* spp. The blackish membrane marked with conspicuous white nervures will distinguish this pretty species from its nearest relatives.

5. **Orthotylus coagulatus** Uhler.

Size and aspect of *flavosparsus* nearly, but with the head narrower and the eyes larger and more prominent; pale green, clothed with minute whitish pubescence and longer black hairs; membrane with a fuscous spot beyond the areoles. Length 4½mm. to tip of the membrane.

Head rather small, viewed from above, acutely angled at apex. Vertex in the female about three times as wide as the eyes; flattened toward the base, leaving the basal carina sharp and prominent across its whole width; in the male narrower, hardly twice as wide as the large eyes, with the base scarcely impressed and the carina less prominent. Clypeus large and very prominent. Antennæ long and slender, the basal joint scarcely as long as the head, surpassing the tylus by one-half its length; third but little shorter than the second. Pronotum short; sides straight or feebly concave in the male; callosities prominent. Elytra moderately long, the tip of the abdomen reaching to the middle of the cuneus in the male, sometimes surpassing its apex in the female.

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Dextral hook of the male genital segment short, knob-like; the sinistral large, convex, filling the excavation at the apex of the genital segment; its apex broadly rounded.

Color pale green, becoming yellowish, especially on the head and beneath; the color on the elytra apparently coagulated so as to leave irregular pale spots and marks. Vertex and pronotum sometimes with a continuous pale median line. Antennæ and legs soiled yellowish; the tibial bristles, tips of the tibiæ and apical one-half of the tarsi black. Membrane slightly enfumed at apex; apical inner edge of the larger areole broadly green or fuscous; at the tip of the cuneus is a white area followed by a distinct fuscous cloud. Upper surface clothed with minute pale pubescence and longer black hairs, all of which are easily rubbed off.

The types were from Colorado. I found it quite common in that state and have taken a few in San Diego County, Calif., at Lakeside and Alpine, and Mr. H. G. Barber has kindly sent me a specimen from the Huachuca Mountains, Arizona, taken July 20. The mottled aspect of the elytra and the variegated membrane will distinguish this species.

6. **Orthotylus flavosparsus** Sahlberg.

Small, oblong-ovate; clear green, becoming yellowish on the callosities, head and lower surface; membrane slightly enfumed, with the surface of the areoles pale green. Length 4mm. to tip of membrane.

Head about as in *viridicatus,* small with the eyes prominent in the male, less so in the female. Vertex flat with a median areolate depression before the prominent basal carina, less conspicuous in the female. Front but moderately convex, the clypeus small with its base rather above the line of the antennæ. Antennæ short, the basal joint unusually short. Pronotum as in the allied species, short and flat with prominent callosities. Elytra short, the apex of the abdomen in the male reaching to the middle of the cuneus, nearly to the apex of the membrane in the female.

Dextral hook of the male genital segment minute, rounded; sinistral rather large, broad at base, much extended outwardly

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and acute at apex, the apical margin of the hook truncated across its whole width.

Color, clear green, becoming yellowish on the callosities, head, and lower surface, and the legs and antennæ pale, the latter somewhat infuscated beyond the basal joint; tip of the tibiæ and the tarsi brown or black. Upper surface clothed with black hairs, interspersed with pale buff ones, the latter segregated into roundish spots, giving the insect a mottled aspect when fresh. Membrane slightly evenly infuscated, the nervures and surface of the areoles clear green.

This European species seems to be widely distributed in the east. I have examples from Montreal, Ottawa, Lake Temagami, P. Q., and Ridgeway, Ont., also from New York, New Jersey, District of Columbia, Virginia, Ohio, and Kansas. It may at once be distinguished from its allies by the green surface of its areoles and the peculiar yellowish mottled aspect of the fresh examples.

7. **Orthotylus chlorionis** Say.

Closely allied to the preceding; clear green, clothed above with minute fuscous hairs, but without an intermixture of pale ones, at least in any of the numerous specimens I have seen; membranal areoles concolorous. Length 3½-4mm. to tip of the membrane.

Head as in the preceding, but with the vertex and front somewhat fuller; the basal depression of the vertex narrow, ill-defined before, the basal carina prominent. Antennæ short, the first joint shorter than the head. Pronotum short, the sides straight, with the anterior angles well rounded. Callosities bounded by a sharp depressed line behind, not as prominent as in the allied species. Elytra rather short, the abdomen reaching to about the tip of the cuneus in both sexes. Tibial bristles short and weak, not longer than the thickness of the joint.

Male genital pieces very small, the dextral hook hardly more than twice longer than broad, ligulate; sinistral curved, narrow, parallel, lying along the ventral edge of the genital segment.

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Color a uniform clear green, becoming yellowish on the callosities, head and beneath. Antennæ and legs dull testaceous, the apex of the antennæ somewhat infuscated. Membrane moderately infuscated, iridescent, the nervures green, vestiture of the upper surface minute and sparse, fuscous.

Say's material was from Indiana. I possess examples from Quebec, District of Columbia and California. This pale green little species may be distinguished from *flavosparsus* by the concolorous areoles and the want of intermixed pale hairs; from *fraternus* and *uniformis,* by the shorter elytra, and from *translucens,* by the dark vestiture and the genital characters of the male.

8. **Orthotylus fraternus,** new species.

Very close to *translucens,* but with longer elytra clothed with fuscous instead of pale hairs. Length 4mm. to tip of the elytra.

Head substantially as in *translucens,* but with a transverse linear impression before the basal carina. Antennæ obviously more slender. Pronotum shorter than in the allied species, the sides feebly concavely arcuated with the angles more rounded. Elytra longer, the apex of the abdomen not surpassing the tip of the corium, the cuneus noticeably longer. The male genital characters are very close to those of *translucens,* but there are some differences. The dextral hook is more clavate at apex, the sinistral more curved and less inflated and the ventral aspect of the genital segment is shorter and less acutely produced.

The color of the present species is distinctly darker and more olive green, becoming yellowish toward the costa; the antennæ are darker throughout, the hairs on the upper surface are distinctly fuscous instead of pale, and the longer bristles of the tibiæ are blackish.

Described from five male examples taken at La Jolla, Calif., April 29, 1914; Alpine, San Diego County, Calif., June 5, 1913, and Pasadena, Calif., in May. This species I place next to *chlorionis* on account of its fuscous vestiture, but it is very close to *translucens,* although I believe it quite distinct. The genital characters are of little value here, but the darker color, longer elytra, fuscous vestiture, slender cuneus, more slender

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and dusky antennæ and the linear impression on the base of the vertex will certainly distinguish it. I have one female taken at San Diego in April, 1913, that I believe belongs here. It has the elytra shorter, with the cuneus proportionately shortened and the sides of the pronotum almost rectilinear, but it has the same rounded pronotal angles, linear impression on the base of the vertex, dusky antennæ and fuscous vestiture.

Type, male, from Alpine, in author's collection. Paratypes in Museum of California Academy of Sciences (No. 307) and in author's collection.

9. **Orthotylus uniformis,** new species.

Aspect of the preceding, the head and beneath becoming more or less yellowish. Length 5½-6mm. to the tip of the membrane.

Head more oblique than in the allied forms, leaving the apex more pointed when viewed from above. Eyes prominent, rounded, viewed from the side elongated and somewhat oblique. Vertex slightly flattened, the basal carina but feebly distinguished. Front but slightly convex; clypeus prominent; facial angle rather less than a right angle. Pronotum strongly narrowed before, rather flat, the callosities but little prominent, sides unusually oblique, slightly concavely arcuated; humeri prominent. Elytra long, the apex of the abdomen scarcely surpassing the base of the cuneus in the male, almost reaching to its tip in the female. Rostrum long, reaching on to the hind coxæ.

Dextral hook of the male genitalia short, straight, ligulate, its extreme apex incurved and subacute; sinistral hook long, curved in almost a semicircle, the apex slender and acuminate. Both hooks white in the dried specimens.

Color a uniform pale yellowish-green, becoming paler on the callosities, head, legs and lower surface; tip of the tarsi and of the rostrum black. Apical two joints of the antennæ infuscated. Upper surface sparingly clothed with short pale hairs. Membrane very faintly enfumed and highly iridescent, the nervures green.

Described from 15 examples representing both sexes, taken about Fallen Leaf Lake near Lake Tahoe, Calif., at an alti-

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tude of 6,000 to 7,000 feet, during July, 1915. This is a tender pale green insect that must depend upon the characters of the male genitalia for final identification. I have also in my collection one pair from Salamanca, N. Y., and an example from Phoenix, Ariz., that have the same male genitalia and are otherwise inseparable from my Tahoe material.

Type, male, and allotype in collection of the University of California. Paratypes in Museum of California Academy of Sciences (Nos. 308, 309), collections of the University of California, and of the author.

10. **Orthotylus translucens** Tucker.

Aspect of *uniformis,* but smaller with the head obviously shorter and more vertical and the first antennal joint shorter and thicker. Length 4mm. to the tip of the membrane.

Head small, short. Eyes unusually large and prominent; viewed from the side, ovate, reaching almost to the gula. Vertex flat with a large depressed area, the basal carina prominent but obtuse; front scarcely convex; clypeus small, the facial angle obtuse. Antennæ, first joint obviously shorter than the head when viewed from above; the second thick, scarcely thinner than the first and about four times longer. Pronotum short, one-half as long as its basal width, the anterior angles well rounded; callosities not prominent; basal lobe of the scutellum rather broadly exposed. Elytra long, the abdomen reaching to about the middle of the cuneus.

Male genitalia small, dextral hook short, a little widened toward its apex; sinistral also short and spatulate, but little longer than the dextral, its rounded apex fringed with short hairs. The large ventral aspect of the genital segment with a narrow subacute apex which rather surpasses the hooks.

Color clear green, becoming yellowish on the base of the scutellum, callosities, head and beneath. Apical two joints of the antennæ and tip of the second infuscated. Knees darker green in my examples; apex of the tarsi black. Elytral nervures darker green, most pronounced on the costal edge of the cuneus. Membrane very faintly infuscated, iridescent, the nervures pale green. Upper surface sparsely clothed with short pale hairs.

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Redescribed from one pair taken on burdock growing on the bank on Niagara River at Buffalo, N. Y., June 28, 1908, and two males taken at Elma, N. Y., August 25, 1912.

I believe I have rightly identified Mr. Tucker's species as this, although certainty is impossible without reference to the type. I know, however, of no other species that answers so well to his description. The insects of this genus are without a pronotal collum and Mr. Tucker must have referred to the space anterior to the callosities as the collum.

11. **Orthotylus senectus,** new species.

Form of *coagulatus* but larger; whitish, irregularly dotted with green above. Length 4mm. to tip of membrane.

Head a little oblique, with the eyes two-thirds the width of the base of the pronotum. Vertex flat, twice as wide as the eyes; basal carina straight, prominent. Front strongly convex, almost overhanging the base of the clypeus. Clypeus very prominent, strongly arcuated before. Eyes prominent, viewed from the side reaching two-thirds the way to the gula. Antennæ rather short, the basal joint nearly as long as the head; third nearly or quite as long as the second. Rostrum almost attaining the apex of the hind coxæ, the first joint a little surpassing the base of the head. Pronotum formed as in *coagulatus,* the callosities prominent and the hind margin straight. Basal lobe of the scutellum but moderately exposed. Elytra as in the allied species, the costal margin gently bowing, widest opposite the tip of the clavus. Bristles of the hind tibiæ pale, shorter than the thickness of the joint.

Color whitish tinged with green on the pronotum and elytra and with fulvous on the head and legs; either side of the vertex with a faint fulvous cloud leaving the median line white. Posterior lobe of the pronotum and the elytra irregularly dotted with bluish green points. Membrane almost white, the nervures green. Upper surface sparsely clothed with short pale hairs.

Described from two female examples taken by me at Pueblo and Manitou, Colo., in July, 1900. This species is quite distinct by its whitish color dotted with green above. It doubtless lives on the whitish vegetation of the semi-arid districts

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of Colorado. It is not impossible that the green elytral points may bear stiff dark hairs in fresh individuals.

Type, female, in collection of the author. Paratype, female, in Museum of California Academy of Sciences (No. 310).

12. **Orthotylus viridis,** new species.

Form of *dorsalis* but with the head and pronotum of *formosus;* pale green, with the head, anterior lobe of the pronotum and legs yellowish. Length 5mm.

Head as in *formosus,* a little oblique. Vertex slightly flattened, the basal carina straight and acute, not tumid and gently arcuated as in *formosus.* Front moderately convex. Clypeus small, prominent. Rostrum attaining the apex of the intermediate coxæ. Pronotum shaped as in *formosus,* with its sides feebly concavely arcuated and the humeri rounded; callosities large, but little prominent. Elytra nearly parallel, a little wider than in *uniformis.* Upper surface clothed with a minute pale pubescence.

Dextral hook of the male genitalia broad at base, tapering along its upper edge to an incurved subacute point, which nearly attains the opposite wall of the segment; sinistral slender, acute, surpassing the sinistral notch.

Color a nearly uniform green, usually quite strongly tinged with fulvous-yellow on the head, anterior lobe of the pronotum and scutellum, legs and venter, the costa often paler or whitish. Antennæ quite strongly infuscated, especially on the basal and apical joints. Apex of the tarsi blackish. Membrane whitish-hyaline, very slightly enfumed, the nervures pale green.

Described from two males and six females taken by Mr. H. H. Knight at Batavia, N. Y., July 5 and August 2, 1914, and one female taken by Mrs. Annie Trumbull Slosson at Lake Toxaway, N. C. This insect is most closely related to *formosus* and serves to connect that species with *dorsalis* and its allies on the one hand and *uniformis* and related forms on the other.

Type, male, and allotype in collection of H. H. Knight. Paratypes in collections of H. H. Knight, Mrs. A. T. Slosson, Museum of California Academy of Sciences (No. 311), and collection of the author.

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13. **Orthotylus nigrinasi**, new species.

Size and form, about, of *viridicatus*, the head a little larger and the eyes larger and more prominent; color pale green, the green on the elytra segregated, leaving clear places; first antennal joint biannulate with black, the apex of the head conspicuously black. Length 4mm. to tip of the membrane.

Head large, two-thirds as wide as the hind margin of the pronotum. Eyes unusually prominent; viewed from the side, but little longer than broad. Vertex flattened, leaving the hind margin distinctly carinate almost to the eyes. Front prominent, strongly convex; clypeal sutures deep. Basal antennal joint about as long as the head, the second scarcely three times longer. Pronotum almost flat, the callosities scarcely prominent; anterior margin straight, sides feebly concave, the anterior angles but little rounded; humeri prominent. Elytra flat, the tip of the cuneus scarcely surpassing the apex of the abdomen.

Color above green, the pronotum before, head and all beneath, pale or yellowish, more or less tinged with green; the green of the upper surface being gathered into irregular patches, especially on the elytra, leaving pale areas more numerous toward the costa. Base of the vertex with a short brown longitudinal median line; neck with a square black spot behind each eye, which is scarcely noticed unless the head is exserted. Apex of the head deep black, polished, the bounding line passing across the apex of the front just above the base of the clypeus and obliquely down each side a little below the lower angle of the eyes. Antennæ pale (apical joints wanting); the first joint black at base with a broad black annulus just before the apex; second narrowly black at base and dusky toward the apex. Membrane but slightly enfumed, with a darker cloud beyond the tip of the areoles; nervures green. Vestiture wanting from the type, but apparently pale. Legs pale, apical half of the tarsi, extreme tip of the tibiæ and apex of the rostrum black.

Described from one female taken by Mr. F. Payne at El Paso, Texas, August 31, 1911. The annulated first antennal joint and the remarkably black "nose" will at once distinguish this very distinct species.

Type, female, in author's collection.

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GROUP II (Subgenus *Orthotylus* ?)

14. **Orthotylus ovatus**, new species.

Form nearly of *Lygus apicalis*. Ovate, broader than the typical forms of this genus; green, nearly uniform, clothed with sparse black deciduous hairs and minute white pubescence; membrane infuscated. Length 4½mm. to tip of membrane.

Head broad, convex; vertex flattened, transversely depressed before the prominent basal carina. Front unusually convex, polished; clypeus small and but little prominent. Eyes large, about one-half the width of the vertex; viewed from the side ovate, a little oblique, reaching below the middle of the sides of the head. Antennæ normal, the first joint shorter than the head. Pronotum transverse, more convex than usual in this genus; anterior angles well rounded; callosities large, moderately elevated. Elytra short and broad, the costa regularly but not greatly arcuated, the apex of the abdomen passing the middle of the cuneus in the male, attaining its apex in the female. Rostrum long, reaching about to the base of the venter.

Dextral hook of the male genitalia long, widened to the truncated apex, long triangular, with a very sharp spur at the superior apical angle, this spur but little shorter than the width of the piece at that place; sinistral hook broad, ligulate, its rounded apex attaining the sinistral margin.

Color pale green, becoming more or less yellowish. Upper surface clothed with short black hairs and a minute white pubescence, easily denuded. Antennæ a little infuscated. Membrane quite strongly infuscated, usually pale at base, the nervures pale. Tibial bristles pale. Tip of the last tarsal joint black. In faded specimens the thickened costal nervure is the last to lose its green color.

Described from numerous individuals beaten from juniper trees along Glen Alpine Creek near Fallen Leaf Lake, Calif., during July.

This species is very close to *Oncotylus puberus* Uhler, but after a careful examination of the types I am unable to consider them the same.

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Type, male, and allotype in collection of University of California. Paratypes in Museum of California Academy of Sciences (No. 312), collection of the University of California and author's collection.

15. **Orthotylus catulus,** new species.

Form of *ovatus,* but a little broader; aspect somewhat of *Oncotylus punctipes* Reut.; uniformly pale testaceous-gray or a little brownish. Length 4½mm. to tip of membrane.

Head more triangular before and less convex than in *ovatus.* Vertex flattened, forming a large depressed area, rounded before; basal carina very obtuse; front but moderately convex. Clypeus large and prominent, its basal suture somewhat above the line of the antennæ. Antennæ rather short; basal joint obviously shorter than the head when viewed from above, exceeding the clypeus by less than one-third its length; second little thinner than the first. Pronotum less convex than in *ovatus,* but more so than in the *flavosparsus* and *dorsalis* groups; sides straight; anterior angles scarcely rounded; anterior margin distinctly concavely arcuated; callosities large, not prominent. Elytra broad, the costa rather strongly arcuated; apex of the abdomen reaching the base of the cuneus in the male, rather surpassing its apex in the female. Rostrum long, about attaining the base of the abdomen.

Male genital pieces very small; dextral hook short, ovate, scarcely longer than broad; sinistral broad, irregularly triangular, filling the sinistral notch, its broad apex oblique with the angle rounded.

Color a nearly uniform pale testaceous, having a whitish aspect in life; the elytra more or less infuscated, the membrane sometimes a little more deeply infuscated with the nervures pale. Pectoral pieces tinged with fulvous. Tips of the tarsi and rostrum black. Upper surface clothed with short fuscous hairs, which are but little darker than the surface of the insect. Antennæ scarcely darker at apex.

Described from numerous examples taken on *Gnaphalium uliginosum* at Hamburg, N. Y., June 6, 1909, and at Niagara Falls, June 13. The pale testaceous color of this insect gives it the appearance of being immature.

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Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (Nos. 313-315), collection of the University of California and author's collection.

GROUP III (Subgenus *Diommatus* Uhler).

16. **Orthotylus languidus,** new species.

Larger than *dorsalis,* elongated, with somewhat the aspect of a *Plagiognathus;* a pale immature looking insect with faint fuscous markings in the male. Length 5½mm. to tip of membrane.

Vertex flattened, the basal carina prominent, the impression before it forming two fovæ as in most of the *dorsalis* group. Front convex, especially in the female. Eyes large; in the male two-thirds the width of the vertex, in the female about one-half. Antennæ rather short. Pronotum long, its length two-thirds its basal width; sides very feebly concave, the anterior angles well rounded; callosities large, prominent. Elytra nearly parallel, the costa a little arcuated; almost subhyaline in texture; apex of the abdomen in the male reaching the middle of the cuneus, in the female attaining its apex.

Dextral hook of the male genitalia large, very broad and convex at base, the apex rather abruptly narrowed and incurved with its apex rounded; sinistral small, linear, lying along the lower margin of the very deep sinistral notch.

Color pale whitish-testaceous, with the elytra almost diaphanous and the typical markings much reduced. Upper surface clothed with rather long and dense pale hair. In the female the colors are almost uniform over the whole surface, with only the extreme tips of the tarsi infuscated. The male is quite distinctly clouded with brown or fuscous on the disk of the vertex and on the pronotum behind the callosities, and there is a faint cloud at the apex of the clavus and two elongated ones before the apex of the corium; the membrane also has an elongated fuscous mark beyond the apex of the areoles. Sides of the basal lobe of the scutellum black. Abdomen and sternum more or less infuscated with the connexivum paler.

Described from numerous examples taken on willows at Mussey's and at Grossmont in San Diego County, Calif., in

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April and May. This species has a peculiar washed-out immature look, which, with its slightly larger size, will distinguish it from our other willow species.

Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (No. 316), collection of the University of California and in author's collection.

17. **Orthotylus formosus,** new species.

Elongate-ovate, pale green or yellowish, polished, the typical markings reduced; hind margin of the pronotum slenderly black and there is a black mark behind the callosities. Length 7mm. to tip of the membrane.

Head somewhat oblique, not so nearly vertical as in our other species. Vertex scarcely flattened, the basal carina prominent; front broad, convex, polished; clypeus narrow, prominent and strongly arcuated. Eyes not very prominent; viewed from the side, oval, oblique, reaching below the middle of the side of the head. Antennæ long, the basal joint longer than the head, surpassing the clypeus by at least three-fourths its length; second about three and a half times the length of the first. Pronotum long, much narrowed anteriorly, its length two-thirds its basal width. Callosities large, oval, the disk behind them rather strongly convex and polished. Scutellum large, its basal lobe well exposed. Elytra long with the costal margin gently arched; apex of the abdomen reaching to about the tip of the cuneus. Rostrum attaining the apex of the intermediate coxæ. Oviduct of the female long, beginning before the middle of the venter.

Color a clear pale greenish, becoming yellowish on the scutellum, pronotum, legs and lower surface; basal lobe of the scutellum and head fulvous. Antennæ and tarsi black, the basal joint of the former dusky green. Hind edge of the pronotum and an arc behind the callosities which may be extended in a sinuate transverse line, black. Vertex with two subbasal dashes and two minute approximate points before them brown; the base of the clypeus with a small fuscous spot. Elytra marked with a slender black line next the scutellum and a shorter one on the apical margin at base of the membrane; middle line of the clavus with a long fuscous ray and near the

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inner angle of the corium is an oblong fuscous spot. Membrane more or less infuscated, with a pale median vitta, the nervures green. Abdomen more or less greenish with the stomata darker and the tip of the oviduct black. Upper surface sparsely clothed with pale hairs.

Described from two female examples taken from alder bushes on the south slope of Mt. Tallac above Glen Alpine Springs, near Lake Tahoe, Calif., July 30, 1915. I tried in vain to find this species on the alders growing along Glen Alpine Creek two or three hundred feet lower. It is probable that the species was not then fully in season.

Type, female, in collection of University of California. Paratype, female, in Museum of California Academy of Sciences (No. 317).

18. **Orthotylus modestus,** new species.

A little broader than *dorsalis;* pale gray, the dark markings much reduced, those on the pronotum forming two transverse vittæ. Length 5mm. to tip of membrane.

Head about as in *dorsalis.* Vertex narrowly flattened before the basal carina. Front a little more convex and less polished than in *dorsalis.* Pronotum more convex and a little broader anteriorly, the sides nearly rectilinear; anterior angles well rounded; surface transversely rugose; callosities scarcely prominent, ill-defined. Basal lobe of the scutellum a little exposed. Elytra rather short, the abdomen surpassing the tip of the cuneus; costal margin regularly slightly arcuated, rather more so than in *dorsalis.* Tibial spines longer and stouter than in the allied species, distinctly longer than the thickness of the segment.

Color, female, pale greenish shading to yellowish in places, deeper green along the claval suture. Upper surface distinctly gray-pubescent. Head pale tinged with fulvous, with a brown dot on the base of the clypeus. Antennæ pale, a little infuscated. Pronotum pale with a fuscous arc behind each callosity. These arcs may unite and form a transverse vitta, not attaining the margin. Hind margin with a broader fuscous vitta, which omits the humeral angles. Basal area of the scutellum more or less fulvous. Elytra pale or somewhat greenish; the

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clavus, except at base and apex, fuscous; corium with a large fuscous cloud on the inner angle, which, at the middle, has an extension toward the costa; cuneus pale. Membrane well infuscated, the nervures pale except at their base. Beneath and legs pale, more or less tinged with green, the apex of the tarsi black.

Male much darker; head above, basal joint of the antennæ, pronotum, clavus, membrane and most of the lower surface black; the black color on the corium more extended and occupying fully one-half the surface; first antennal joint black; second, brown, yellowish at base; third and fourth, fuscous.

Dextral hook of the male genitalia black, broad and strap-like, transverse, a little widened at base, its blunt apex incurved, almost reaching the sinistral wall; sinistral hook straight, apparently terete, not thicker than the second antennal joint, surpassing the apex of the ventral surface of the genital segment.

Described from five males and eight females. Of these I took two females at Salamanca, N. Y., July 20, 1911, and one at Buffalo, N. Y., August 4, 1901. Mrs. Annie Trumbull Slosson has sent me three females taken at Delaware Water Gap, Pa., and from Mr. H. H. Knight I have received three males and two females taken at Honeoye Falls, N. Y., July 1, 1915, and two males taken at Batavia, N. Y., July 10, 1914.

Type, female, in collection of author. Allotype, male, in collection of H. H. Knight. Paratypes in collections of H. H. Knight, Mrs. A. T. Slosson, Museum of California Academy of Sciences (No. 318) and in author's collection.

19. **Orthotylus dorsalis** Provancher.

Elongated with the elytra nearly parallel; black; head, at least the occiput, sides and median vitta, usually, of the pronotum, broad costal margin, lower surface excepting a broad lateral vitta, legs and the antennæ of the female, pale or greenish. Length 5-5½mm. to tip of membrane.

Head almost vertical. Eyes prominent, especially in the male; viewed from the side oval, little longer than broad; reaching below the middle of the head. Vertex narrowly flattened and a little excavated before the basal carina; in the male but little broader than the eye, about twice as broad in the fe-

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male. Front moderately convex, polished; clypeus small, but little prominent. Antennæ rather short, the basal joint as long as the head; second about three and one-half times as long as the first. Pronotum rather long and much narrowed before, its length two-thirds its basal width, the sides distinctly concavely arcuated with the anterior angles well rounded; surface rather flat, obscurely transversely rugose; callosities large, oval, moderately prominent, distinctly separated by a depressed area. Basal lobe of the scutellum well exposed. Elytra nearly parallel, the costa feebly arcuated; tip of the abdomen nearly attaining the apex of the cuneus in the male, quite so in the female.

Male genital hooks black; the dextral large, slender at base and expanded to an oblique triangular apex which passes the middle of the anal opening; sinistral hook finger-like, considerably surpassing the apex of the segment, clothed with minute hairs.

Color above black; beneath pale with a blackish vitta along each side, which in the male may be so extended as to cover nearly the entire lower surface. Pronotum pale with two approximate black dorsal vittæ which in the male are so extended as to cover nearly or quite the entire surface. Head in the male black, polished, with the occipital margins, antennal sockets, lower cheeks and tip of the clypeus pale; in the female pale with a large brown annulus on the front and sometimes with two small points above it and a large black spot between the antennæ covering the disk of the clypeus, apex of the front and inner cheeks. Antennæ black in the male, pale and somewhat infuscated in the female. Scutellum black, with a pale median vitta in the female and sometimes in the male. Pale costal border of the elytra encroaching upon the black disk along the claval suture and principal nervure, especially in the female; cuneus pale with the apex a little infuscated at times. Membrane infuscated, the nervures pale and with a pale spot at their apex in the female. Legs pale, the weak tibial bristles also pale, the apex of the tarsi black. Upper surface sparsely clothed with minute pale hairs.

Redescribed from a good series taken at Quinze Lake, P. Q., and about Buffalo, N. Y. It occurs on willows. I would not be surprised to learn that the females of this species are

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dimorphic, some of them being like the males in color. I have carefully studied the types of both Provancher's and Uhler's species (*congrex*) and they seem to be absolutely identical.

20. **Orthotylus marginatus** Uhler.

Closely allied to *dorsalis,* but with the females colored dark like the males and with different male genital characters. Length 5½mm. to tip of membrane.

Vertex but little flattened, with a slight depression before the feeble basal carina; front but slightly convex, polished; clypeus small and less prominent than in most of our species. Eyes unusually large; viewed from the side broadly ovate, reaching nearly to the gula, very little smaller in the female than in the male. Pronotum almost smooth, the sides distinctly concave, the anterior angles well rounded; callosities prominent, usually connected anteriorly by a slight ridge. Basal lobe of the scutellum well exposed. Elytra long, nearly parallel, the costal margin but feebly arcuated; apex of the abdomen reaching the middle of the cuneus in the male and nearly to its tip in the female. Upper surface rather sparsely clothed with pale appressed hairs. Rostrum long, reaching well on to the hind coxæ.

Dextral hook of the male genitalia large, pale, reaching nearly across the anal opening, its apex obliquely rounded and armed with a few comb-teeth, near the base produced dorsally and backward in a sinuated acute projection which is about one-half as long as the lower member; sinistral hook long, flattened and expanded at the rounded apex, produced for one-half its length beyond the ventral apex of the genital segment.

Color as in the male of *dorsalis,* black; occiput, lower cheeks, gula, base of the vertex, median vitta of the pronotum, at times continued over the scutellum, and the sternum, pale or tinged with fulvous; costal margin of the elytra, middle of the venter and the legs pale greenish-yellow. Pale color of the costa sometimes encroaching upon the base of the clavus along its suture and on the principal nervure of the corium in the female, rarely in the male; inner angle of the cuneus usually infuscated. Membrane blackish with the nervures pale at apex.

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Redescribed from a good series taken, with *dorsalis,* on willows and thorn bushes, there probably accidental. The males of this species and of *dorsalis* are nearly indistinguishable except in their genital characters, but in *dorsalis* they more often have the pronotum and scutellum entirely black.

21. **Orthotylus molliculus,** new species.

Allied to *dorsalis* with the dark markings much reduced, the face with a black X-shaped mark. Length 5mm. to tip of membrane.

Head broader than in the allied species. Vertex flattened, with a distinctly foveate impression before the prominent basal carina. Front but slightly convex; clypeus small. Eyes large, nearly two-thirds the width of the vertex; viewed from the side short, ovate, reaching nearly to the gula. Antennæ short; third and fourth joints together not three-fourths the length of the second, the fourth about equal to the first and two-thirds the length of the third, a little dilated and flattened at apex. Pronotum shorter than in *dorsalis,* more convex, the sides feebly concave, the anterior angles rounded; callosities large, closely approximated, moderately elevated. Basal lobe of the scutellum but little exposed. Elytra rather short, about as in female *dorsalis,* the apex of the abdomen hardly reaching to the middle of the cuneus.

Male genitalia whitish; dextral hook rather large, a little curved inward and upward, the apex truncate and drawn out dorsally into about four sharp teeth, near the base with an oblong plate projecting dorsally, the inner angle of which is produced in an acute tooth; sinistral hook long and spatulate, much exceeding the ventral aspect of the segment.

Color whitish-testaceous, perhaps tinged with green in life, with a slight tint of yellow on the head and scutellum; the basal lobe of the scutellum marked with black and fulvous. Face marked with a large black X from the antennæ to the basal fovæ, the pale angle above the clypeus sometimes filled in with black; clypeus and outer cheeks in part black. Antennæ black. Callosities black, connecting with a large fuscous spot on either side of the disk of the pronotum. Sides and suture of the scutellum black. Elytra pale with a fuscous cloud

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covering the disk of the clavus, another on the corium within, exterior to which is a short fuscous ray; cuneus entirely pale. Membrane blackish-fuscous, the nervures pale at apex. Extreme base of the elytra touched with fuscous. Pleural pieces mostly black. Abdomen black with the disk and margins pale. Legs very pale green, the tarsi infuscated and black at apex. Upper surface clothed with short pale pubescence.

Described from two male examples taken on willows at Mussey's and near Grossmont, San Diego County, Calif., in April and May, 1913.

Type, male, in author's collection. Paratype, male, in Museum of California Academy of Sciences (No. 319).

22. **Orthotylus affinis**, new species.

Very near *molliculus*, a little larger and darker with the basal joint of the antennæ pale, the pronotum narrower before, the pale costal border broader and not marked with a fuscous ray, the sides of the body beneath scarcely marked with black, and a different male genitalia. Length 6mm. to tip of membrane.

Head as in *molliculus*, the vertex strongly impressed before the prominent basal carina, the clypeus but moderately prominent. Eyes oval, viewed from the side proportionately narrower than in the allied species. Pronotum apparently longer, the pale space before the callosities broader and the anterior angles much rounded, making the anterior margin look shorter. Legs longer, the hind femora distinctly surpassing the tip of the abdomen.

Male genitalia larger, pale; the dextral hook produced into a long sickle-shaped piece, acute at apex and serrated for a space along the external edge, the base angled but without a square projection, the curve forming a little more than a half circle; sinistral hook longer, a little curved and distinctly expanded toward the apex.

Color a very pale testaceous or greenish. Vertex with a pair of subtriangular black marks in the foveate basal impressions. Front with a blackish arc on either side, united above where they nearly or quite connect with the basal marks; on the base of the clypeus is a black polished spot which encroaches

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upon the outer cheeks. Antennæ dark greenish-piceous, the basal joint more green. Sides of the pectus and abdomen with a narrow blackish vitta which is wanting in the female. Pronotum marked with a broad black vitta on either side, usually connected with the black callosities. Scutellum black, the anterior lobe sometimes marked with fuscous, the posterior with a linear median pale vitta. Elytra blackish-fuscous, the broad costa and a slender line along the commissure and suture of the clavus pale, the cuneus entirely pale. Membrane deeply infuscated, the nervure pale except at base. Legs greenish, the tibiæ more dusky, the apex of the tarsi black.

Described from numerous examples taken from willows about Fallen Leaf Lake, near Lake Tahoe, Calif., in July, 1915. Best distinguished from *molliculus* by the narrower and more rounded anterior margin of the pronotum, the linear pale vitta on the scutellum, the narrower blackish lateral vitta beneath, the want of a fuscous ray in the pale costal area, and the dark olive-green antennæ which become blackish at times. Male genital hooks much more developed and very characteristic.

Type, male, and allotype in collection of University of California. Paratypes in Museum of California Academy of Sciences (Nos. 320, 321), collection of the University of California and in author's collection.

23. **Orthotylus angulatus** Uhler.

Smaller and more slender than *dorsalis;* dark fuscous-brown, base of the pronotum sometimes paler, the base of the corium and the cuneus whitish. Length 4mm. to tip of membrane.

Head short. Vertex short, with an impressed line before the obtuse basal carina; in the female this line connects with two fovæ which are nearly obsolete in the male. Clypeus large, prominent. Eyes large, about two-thirds as wide as the vertex; viewed from the side oval, nearly reaching the line of the gula. Antennæ stout and rather long, the basal joint longer than the head viewed from above; third and fourth slender, together about as long as the second. Pronotum rather short, the sides nearly rectilinear, the anterior angles rounded; callosities large, approximate, little elevated. Anterior lobe of the scutellum

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covered or nearly so. Elytra parallel, narrow, apex of the abdomen but little surpassing the base of the cuneus in the male, hardly attaining its apex in the female. Rostrum and hind tibiæ unusually long, the former attaining the base of the hind coxæ.

Redescribed from two females, one taken by me at Denver, Colo., July 12, 1900, the other, also from Colorado, was sent to me by Prof. Carl F. Baker with the label *Diommatus angulatus* Uhler; they, however, differ from Uhler's description in several points. The clypeus is paler in one of my specimens and not darker in the other, the hind lobe of the pronotum is distinctly paler and the clavus is deep fuscous and not pale yellowish as described by Uhler. There is, however, just such a pale area on the base of the corium adjoining the claval suture. The apex of the cuneus is also but little darkened. These discrepancies can all be accounted for by the ordinary variations found in this genus except the pale clavus, a character found in no species of this genus known to me. It is not unlikely that Dr. Uhler thoughtlessly mistook the cuneate pale mark on the base of the corium for a pale clavus. Unfortunately I have no males of this form.

An examination of one of Uhler's types, kindly sent to me for study by Prof. Gillette, confirms in every respect my determination as given above.

24. **Orthotylus angulatus brunneus,** new subspecies.

This form is very close to that described above as *angulatus* except that the pale mark on the base of the corium is reduced to a line along the claval suture, and the costal margin is narrowly pale.

Male genitalia small; dextral hook ovate at apex; the sinistral lying along the margin of the sinistral notch, its apex curved upward and acute.

Founded on numerous examples taken on willows at many localities in San Diego County, Calif., from April to June. It is possible that an examination of the male genitalia of *angulatus* will show this to be a distinct species, but that is not likely to be the case.

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Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (Nos. 322, 323), collection of the University of California and in author's collection.

25. **Orthotylus cuneatus,** new species.

Very near *angulatus brunneus,* but larger with longer elytra and darker colors; marked as in *angulatus* with a pale wedge-shaped area along the claval margin of the corium. Length 5mm.

Head as in *brunneus,* the vertex with a deep foveate impression before the prominent basal carina. Front feebly convex. Clypeus small, prominent. Antennæ long; basal joint rather longer than the head; second longer than the third and fourth together. Pronotum short, the sides very oblique, sinuated; humeri subacute, prominent; the anterior angles rounded; callosities large, prominent. Elytra long, parallel.

Male genitalia small; dextral hook small, longer than broad; sinistral a little longer, lying in the sinistral notch, its hind edge rounded.

Color sooty-black, a little piceous in immature examples, the antennæ piceous. Legs dark chestnut, the anterior paler or brownish-testaceous in some individuals; coxæ and base of the femora pale testaceous. Elytra with a large wedge-shaped whitish mark lying against the claval suture; apex of the corium and base of the cuneus covered by a rather large whitish spot. Membrane nearly black, a little clearer toward the apex, the nervures black.

Described from two males and five females taken by me about the lower end of Fallen Leaf Lake, Calif., in July, 1915. Structurally this species is very near *brunneus,* but its larger size and stronger coloring, together with the cuneate mark on the base of the corium, will readily distinguish it.

Type, male, and allotype in collection of University of California. Paratypes in Museum of California Academy of Sciences (No. 324), collection of University of California and in author's collection.

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26. **Orthotylus pullatus,** new species.

Closely allied to *brunneus;* blackish, the costal margin narrowly pale; male genital segment long and unusually slender. Length 4½ mm. to tip of membrane.

Basal impression of the vertex large, including two conspicuous pits, the basal carina prominent; front but moderately convex. Eyes, viewed from the side, ovate, reaching nearly to the gula. Pronotum proportionately shorter than in *brunneus,* the sides distinctly arcuated with the humeral angles subacute and upturned; callosities large and prominent. Elytra a little more widened toward the apex of the corium than in the allied species. Antennæ a little thinner than in *brunneus,* the third and fourth joints together scarcely as long as the second.

Genital segment of the male in *brunneus* triangular, hardly longer than broad at base; in *pullatus* nearly cylindrical, about twice as long as wide at base, the apex elliptically rounded. Genital hooks small and black; the dextral elongate ovate, curved inward and backward at apex; the sinistral elongated, lying along the sinistral notch, its apex rounded.

Color blackish-fuscous. Head black, apex of the clypeus sometimes touched with castaneous. Antennæ black. Pronotum at times showing a mere tinge of castaneous behind the callosities. Coxæ at base and the middle of the sternum and venter pale. Elytra a shade paler than the body, the costal margin narrowly pale and extended nearly to the apex of the cuneus. Membrane nearly black, the nervures concolorous or barely touched with pale at apex. Legs dark castaneous. Upper surface clothed with pale pubescence.

Described from one male and eight female examples taken by me May 13, 1915, on willows growing among the sand dunes at San Francisco, Calif. This species is best distinguished from the closely allied *brunneus* by the darker color, the prominent, subacute, humeral angles, and the long, narrow male genital segment.

Type, male, and allotype in collection of University of California. Paratypes in Museum of California Academy of Sciences (No. 325), collection of University of California and in author's collection.

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27. **Orthotylus cruciatus,** new species.

Allied to *lateralis* but much larger with a black scutellum. Aspect somewhat of *Plagiognathus obscurus* Uhl., but larger and more clearly marked. Length 5½-6mm. to tip of membrane.

Head small, polished. Vertex slightly depressed, the basal carina slender and inconspicuous; front convex, highly polished; clypeus small, prominent. Eyes very large, much wider than the vertex; viewed from the side ovate, reaching about to the gula; the apex of the head projecting more than in *lateralis*. Antennæ long, the first joint longer than the head; second scarcely thinner, fully four times the length of the first; apical two together about equal to the second. Pronotum long, nearly flat, the sides feebly concave, the anterior angles subacute; callosities large, little elevated, extending much farther back than in *lateralis;* basal margin feebly concave, leaving the base of the scutellum less exposed. Elytra long, parallel, the apex of the abdomen just passing the base of the cuneus in the male, reaching nearly to its middle in the female; cuneus narrow and acute, its length fully twice its basal width.

Male genitalia pale testaceous; dextral hook long-triangular, its lower angle subacute, the upper rounded; sinistral ligulate and incurved.

Color black and nearly white. Head black, polished; a dot against the inner angle of each eye and sometimes a basal spot pale testaceous or fulvous. Antennæ black. Pronotum with the callosities and broad lateral margins black, the disk pale. Scutellum black, the basal lobe marked with fulvous. Elytra whitish, the clavus and a broad transverse band across the apex of the corium black; cuneus with a fuscous spot before its apex. Upper surface sparsely clothed with short, pale hairs. Beneath pale with a broad black vitta along either side and covering the genital segment. Legs pale yellowish-brown, becoming lighter at base, the tips of the tarsi black.

Described from seven examples, two males and one female, taken by me at Portland, Maine, July 9, 1910; a female taken by Mr. Metcalfe at St. Hilaire, P. Q., July 4, 1907; one male taken by Mr. C. A. Frost at Sherborn, Mass., June 24, 1914, a female taken at Marshfield, Mass., in August, from the

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collection of the Boston Society of Natural History, the last two kindly sent me for study by Mr. H. C. Parshley, and a male taken at Stowe, Vt., July 4, by G. P. Engelhardt. This is a large, clearly marked species and may be known by the black lateral margins of the pronotum and conspicuous cruciate black markings on the elytra.

Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (No. 326), collections of the Boston Society of Natural History of Mr. H. C. Parshley, and in the collection of the author.

28. **Orthotylus lateralis,** new species.

A little larger and broader than *brunneus;* pronotum pale with the lateral margins broadly black. Length 4½mm. to the tip of the membrane.

Head more oblique than in *dorsalis* and its allies. Vertex flat, the foveate depression rather obscure and the basal carina feeble. Front convex, polished, the clypeus small and prominent. Eyes very large, in the female as wide as the vertex, wider in the male; when viewed from the side, ovate, reaching to the gula and but little surpassed by the apex of the head. Pronotum long and much narrowed anteriorly, the sides very slightly arcuated, the anterior angles subacute; callosities very small and placed close to the anterior margin, leaving the impressed bounding line behind them at about the anterior one-third of the pronotum; hind margin a little concave, leaving the basal lobe of the scutellum broadly exposed. Elytra broader than in *brunneus,* about as in *modestus,* nearly parallel, the apex of the abdomen reaching the middle of the cuneus in the male and its apex in the female.

Male genitalia prominent; dextral hook long, pennate, the ventral edge smooth, the dorsal "feathered" or flattened and serrated on the apical half, tapering to an acute point; sinistral long, nearly straight, toward its apex triangularly widened and armed within with a stout tooth.

Color fuscous-brown; head at base and below becoming pale yellowish. Antennæ black. Pronotum pale yellowish, the sides broadly black both above and below. Basal lobe of the scutellum fulvous, apical pale yellowish. Clavus blackish-

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fuscous, the commissure and apex whitish; corium fuscous, the claval suture, slender costal nervure and a ray along the principal nervure, whitish; cuneus fuscous with the basal half almost white. Membrane lightly infuscated, with a darker ray beyond the angle, the nervures fuscous. Sides of the pleural pieces and venter fuscous, the middle line broadly whitish. Legs tinged with yellow, deeper toward the apex of the hind femora; tip of the tarsi black. Upper surface sparsely clothed with pale hairs. In the female the pale colors are much extended.

Described from two males and two females taken by me at Effingham, Kansas, Pueblo and Denver, Colo., all in July, 1900. This species is readily recognized by the yellowish tinge to the vertex and pronotum with conspicuous black lateral margins to the latter and the fulvous base of the scutellum.

Type, male, and allotype in author's collection. Paratypes in collection of the author and in Museum of California Academy of Sciences (No. 327).

29. **Orthotylus knighti,** new species.

Allied to *lateralis,* but longer winged and darker colored, the elytra black with a subcostal pale vitta, which in the female reaches and largely covers the cuneus. Length 5mm. to tip of membrane.

Head short as in *lateralis.* Vertex much depressed and sunken below the level of the eyes; basal impression triangular with the fovæ discernable, the basal carina slender but distinct. Front but little convex, polished; clypeus small, strongly arched before. Eyes very large and prominent; in the male as wide as the vertex, about one-half narrower in the female; viewed from the side, broad ovate, reaching nearly to the gula. Pronotum much narrowed anteriorly; sides distinctly arcuated, the humeri prominent and the anterior angles subacute; callosities prominent, oblique. Elytra long, parallel, the costa straight; cuneus slender. Basal lobe of the scutellum well exposed. Antennæ as in *lateralis,* the basal joint perhaps a little longer.

Dextral hook of the male genitalia black, subtriangular, transverse, its lower edge straight, the upper oblique with the

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obtuse apex incurved; sinistral finger-like or a little thickened toward its apex, a little shorter than the dextral.

Color black, polished on the front and clypeus; vertex, occipital margins and antennal sockets obscurely fulvous. Disk of the posterior lobe of the pronotum in the female broadly dull fulvous, the callosities tinged with the same color. In the male this fulvous disk is much reduced. Coxæ and legs pale fulvous, the apex of the femora and tibiæ becoming infuscated, in the male almost black, the tip of the tarsi black. Disk of the corium in the female with a whitish vitta, broadest near the base and expanded on the cuneus so as to cover all but the inner angle and apical margin. In the male this pale ray is much reduced and confined to the base of the corium. Membrane black with a pale line along the apical margin of the cuneus, which sometimes encroaches upon the apex of the nervures.

Described from one male and three female examples taken on willow at Batavia, N. Y., July 5, 1914, by Mr. H. H. Knight, who has kindly sent them to me for study and to whom it gives me pleasure to dedicate this interesting species.

Type, male, and allotype in collection of H. H. Knight. Paratype in author's collection.

30. **Orthotylus ornatus,** new species.

Size of *formosus,* but proportionately broader. Pale greenish varied with fuscous and sometimes tinged with sanguinous; median line of the pronotum and apical field of the scutellum in the female pale. Length 6mm. to tip of the membrane.

Head vertical. Vertex flat, but little depressed; the fovæ obscure, basal carina distinct. Front scarcely convex; clypeus narrow, moderately prominent. Eyes large, about two-thirds the width of the vertex; viewed from the side broad ovate, but little narrowed below, reaching nearly to the gula. Pronotum broad, rather flat; sides a little concavely arcuated, the humeri prominent; anterior angles but little rounded; surface opaque and distinctly shagreened; callosities little elevated. Antennæ short; first joint as long as the head; second nearly as long as the head and pronotum together; third and fourth conjointly about two-thirds the length of the second. Basal lobe of the scutellum somewhat exposed. Elytra broad, the costa a little

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bowing; cuneus long and narrow, scarcely attaining the tip of the abdomen in the female, surpassing it in the male. Rostrum short, reaching on to the intermediate coxæ.

Dextral hook of the male genitalia broad on its basal half, the ventral margin abruptly produced and incurved at the apex which nearly attains the sinistral margin of the segment; sinistral hook slender and incurved.

Color pale green; sides of the venter and pectus more or less infuscated or black, almost entirely fuscous in the male. Head greenish or reddish-brown; the basal fovæ and two approximate spots on the base of the front fuscous, the latter sometimes forming vittæ; clypeus pale anteriorly. Pronotum dark reddish fuscous, becoming black laterally and behind the callosities or entirely black in the male; median line sometimes enlarged so as to cover the disk posteriorly; lateral edges and the surface anterior to the callosities pale or whitish in the female. Scutellum black, the basal lobe sometimes with a red spot on either side, the disk of the apical lobe pale. Elytra pale or tinged with reddish, the clavus infuscated, at least apically; apical half of the corium irregularly fuscous, omitting the slender costal and apical margins; cuneus whitish, fuscous at apex in the male. Membrane infuscated, the disk of the areoles nearly black, with a darker ray beyond them. Antennæ rufo-testaceous, infuscated at apex, the basal joint brown or black. Legs pale; hind femora infuscated on the apical two-thirds; tips of the tarsi black.

Described from three females and one male taken at Honeoye Falls, New York, in June and July, 1915, by Mr. M. D. Leonard and kindly sent to me for study by Mr. H. H. Knight. The large size and maculated membrane will distinguish this species. It has somewhat the aspect of *Lopidea cuneata* Van D. or of a *Plagiognathus,* but the free connivent arolia and other characters show it to be a true *Orthotylus.*

Type, male, and allotype in collection of H. H. Knight. Paratypes in collections of H. H. Knight and the author.

31. **Orthotylus submarginatus** Say.

Allied to *lateralis,* but rather more slender. Color above, pale salmon yellow, median vitta and slender costal line on the

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elytra and the pronotal margins black. Length 4mm. to tip of the membrane.

Head vertical; base of the vertex depressed, the basal carina prominent. Pronotum a little narrower than in *lateralis,* the humeral angles more prominent; surface sloping, scarcely convex, nearly smooth. Basal lobe of the scutellum well exposed. Elytra nearly parallel; the apex of the abdomen nearly attaining the tip of the cuneus.

Color light salmon-yellow. Tip of the head with a polished black spot covering the apex of the front, inner cheeks and base of the clypeus. Margins of the pronotum rather broadly black both above and below, the black being continued around the humeral angles for a little way. Apical lobe of the scutellum infuscated. Elytra salmon-yellow; a straight commissural vitta covering about one-third of their width and a subcostal line reaching nearly to the apex, black; cuneus pale, its extreme tip touched with fuscous. Beneath pale with a broad black vitta along each side, meeting on the genital segment. Legs pale, the hind tibiæ infuscated or black; tarsi black at apex.

Redescribed from two female examples, one from Kingston, R. I., taken in August, the other taken by me at Hamburg, N. Y., July 10, 1898. The salmon color with the black median vitta and pronotal margins and the submarginal black line on the costa will readily distinguish this pretty species.

32. **Orthotylus candidatus,** new species.

Aspect of *formosus,* but smaller, more nearly allied to *submarginatus.* Almost white, a little tinged with yellow or fulvous; median line of the head and scutellum and the sides of the pronotum narrowly black. Length 5mm.

Head as in *formosus,* more oblique than in most of our species. Vertex considerably depressed, the basal carina prominent and conspicuous. Front polished, but little convex. Clypeus almost tumidly prominent, highly polished. Eyes large, viewed from the side oval and reaching nearly to the gula. Rostrum scarcely attaining the base of the intermediate coxæ. Pronotum as in *submarginatus,* the callosities large, little elevated, their inner margins parallel and closely approximated,

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behind distinguished by a feebly arcuated conspicuous transverse impressed line. Basal lobe of the scutellum moderately exposed. Elytra subhyaline.

Color very pale testaceous, almost white, tinged with yellow on the pronotum, scutellum and legs, and with fulvous on the head, the basal carina of the vertex being of a deeper fulvous. Middle line of the vertex and front, a transverse line between the antennæ, narrow lateral margins of the pronotum, a median vitta on the scutellum, expanded on the basal lobe, and the slender scutellar and commissural edges of the clavus, black. Beneath with a broad percurrent black vitta on either side. Basal joint of the antennæ black; the second ferruginous, fuscous on apical third; third fuscous. Tips of the tibiæ and the tarsi darker. Elytra whitish-testaceous, subhyaline, with an obscure fuscous line inside the principal nervure; the apex of the costal area touched with fulvous. Membrane faintly infuscated, the nervure brownish, the surface of the areole milky-hyaline. Surface very minutely pale pubescent.

Described from a single female example taken by Mrs. Annie Trumbull Slosson on Mt. Washington, N. H. This interesting addition to our Capsid fauna may be distinguished by its whitish color marked with a black line on the vertex, scutellum, sides of the body beneath, and narrow lateral margins of the pronotum. The male is likely to be more broadly marked with black.

Type, female, in collection of Mrs. A. T. Slosson.

33. **Orthotylus necopinus,** new species.

Allied to *dorsalis,* but much larger and a little more widened posteriorly; dark fuscous brown with an obscure dorsal vitta and a pale arc at the base of the cuneus. Length 6½mm. to tip of membrane.

Head as in *dorsalis,* the vertex much flattened, almost excavated before the very prominent basal carina. Front rather prominent, polished; clypeus less prominent than in the allied species, its incised base a little below the line of the antennæ. Eyes large, viewed from the side ovate and reaching nearly to the gula. Pronotum as in *dorsalis,* well narrowed anteriorly; callosities small, prominent; posterior lobe transversely rugose;

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hind margin a little concave, leaving the basal lobe of the scutellum moderately exposed. Elytra gradually widened almost to the apex of the corium, the abdomen nearly attaining the tip of the cuneus. Tibial bristles short and weak, concolorous with the tibiæ. Rostrum short, hardly attaining the base of the intermediate coxæ.

Dextral hook of the male genitalia large, mushroom-shaped, with its distal margin oblique and parallel with the edge of the segment, its apicies rounded; sinistral hook linear and strongly incurved; both hooks pale.

Color brownish-fuscous, becoming black on the front of the head and along either side of the body beneath. Base of the vertex, an elongated spot against the inner margin of each eye and the median line pale or greenish. Anterior margin of the pronotum before the callosities and the middle of the posterior disk pale or greenish, the anterior margin sometimes tinged with ferruginous. Median vitta of the scutellum pale or somewhat ferruginous. Commissural and costal nervures slenderly pale; a pale ray on the base of the corium within the costa extending a little beyond the tip of the scutellum, and a less conspicuous commissural mark from the tip of the clavus to the base of the membrane; incisure at base of the cuneus pale. Membrane deeply infuscated with its nervures pale and with a whitish mark against the apex of the cuneus. Antennæ black. Rostrum and legs brownish-testaceous, the tarsi becoming black. Beneath black and polished with a broad indefinite whitish median vitta extending as far as the genital segment.

Described from one male taken on Mt. Washington, N. H., by Mrs. Annie Trumbull Slosson; a female taken on Mt. Washington, July 5, 1914, and sent to me by Mr. H. H. Knight; a female taken by me at Bretton Woods at the foot of Mt. Washington, June 30, 1909; and another taken at Spring Brook, near Buffalo, N. Y., June 25, 1911. The large size and dark brown color of this species will readily distinguish it. In the male the basal pale ray on the corium is considerably extended.

Type, male, in collection of Mrs. A. T. Slosson. Allotype, female, in collection of the author. Paratypes in Museum of

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California Academy of Sciences (No. 328), collection of H. H. Knight, and author's collection.

34. **Orthotylus fumidus**, new species.

A large fuscous form clothed with gray pubescence. Length 6mm. to tip of membrane.

Head distinctly oblique; vertex scarcely flattened, the basal carina apparently wanting; front hardly convex, transversely striate; clypeus large, but little prominent; apex of the cheeks tumid. Eyes large, prominent; viewed from the side a little oblique, almost attaining the line of the gula. Pronotum moderately sloping, nearly flat, the sides almost rectilinear; callosities large, flat. Basal lobe of the scutellum narrowly exposed. Abdomen reaching to the tip of the cuneus. Legs long for this genus. Rostrum short, not attaining the base of the intermediate coxæ.

Color a uniform fuscous-brown, probably nearly black when fully mature; tinged with rufous on the head, apex of the pronotum, and base of the legs; sides of the venter with a black vitta. Membrane blackish, the nervures of the smaller areole pale. Whole surface clothed with short white deciduous hairs.

Described from one female example taken by me at Ft. Collins, Colo., July 28, 1898. This individual may be somewhat immature, but, while not typical of this genus, the species evidently belongs here and is included to complete the enumeration of our species, so far as they are known to me.

Type, female, in author's collection.

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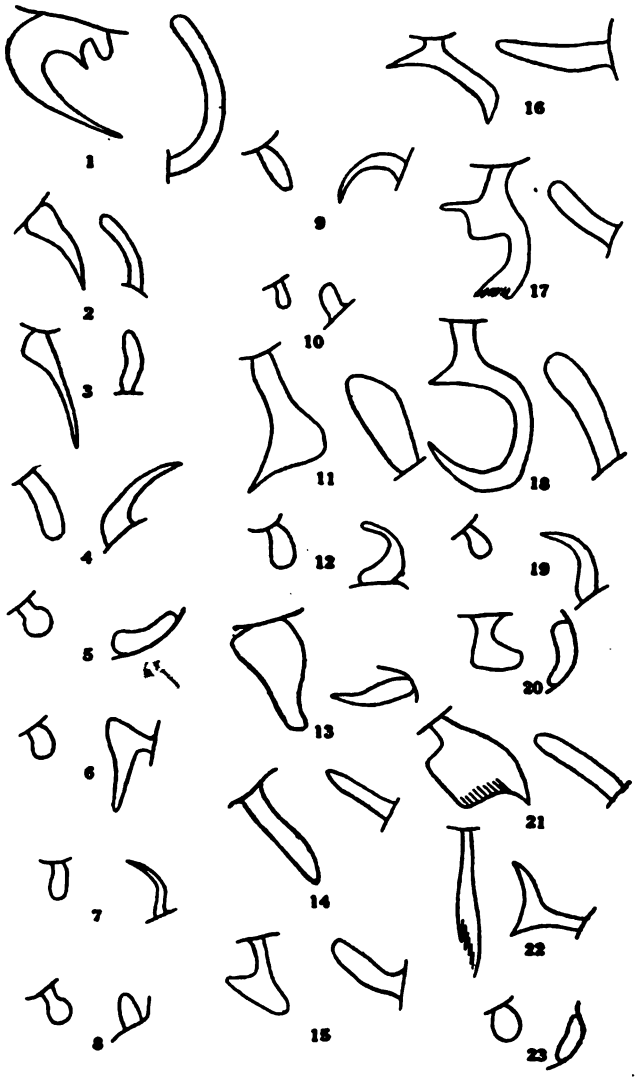

Fig. 1. Male genital hooks of the species of Orthotylus, as viewed from a point vertical to the plane of the hook.

1, Orthotylus insignis; 2, tibialis; 3, ferox; 4, viridicatus; 5, coagulatus; 6, flavosparsus; 7, chlorionis; 8, fraternus; 9, uniformis; 10, translucens; 11, ovatus; 12, catulus; 13, languidus; 14, modestus; 15, dorsalis; 16, marginatus; 17, molliculus; 18, affinis; 19, brunneus; 20, pullatus; 21, cruciatus; 22, lateralis; 23, cuneatus.

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VI

A Catalogue and Host List of the Anoplura

BY
G. F. FERRIS
Of Stanford University

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VI

A CATALOGUE AND HOST LIST OF THE ANOPLURA

BY

G. F. FERRIS

Of Stanford University

INTRODUCTION

The Anoplura (sucking lice) have long been much neglected and much misunderstood, for as late as 1904 no critical, comparative study of the group had ever been made; and this in spite of the fact that the group had had a place in two monumental works upon parasitic insects, Insecta Epizoa of Giebel and Les Pediculines of Piaget. With the exception of a few forms of such peculiar nature that they were almost of necessity given generic rank, the species were for the most part lumped under the genus *Hæmatopinus* and all were regarded as forming a single family, the Pediculidæ. In 1904, Enderlein, in a series of *"Lausestudien"* published in the Zoologischer Anzeiger, broke up the all-inclusive genus *Hæmatopinus* into several genera and elevated this group, as well as certain other groups, to family rank.

There has been some objection to this procedure, but on the whole it has been amply justified by time. The old classification was based upon lack of knowledge and served only successfully to conceal a wealth of remarkably interesting bio-

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logical facts that the newer classification has revealed and emphasized. The remarkable degree to which these parasites are broken up into natural groups that are strictly confined to closely related groups of hosts, is now clearly evident, while previously it was barely hinted at. The problem of their distribution is shown to be almost exclusively the problem of the genetic relationships of their hosts.

In 1908 there appeared, as a part of Wytsman's Genera Insectorum, a catalogue, compiled by Dalla Torre, based upon the work of Enderlein. This catalogue has proved of immense value, but the knowledge of the Anoplura has increased so rapidly since its publication that the additions and corrections have now attained a bulk almost rivaling the original catalogue, and it therefore seems well that a new catalogue should be issued.

These changes and additions may briefly be summarized. Since 1909 nine valid genera have been added to the list and approximately 60 species have been described (the previous catalogue listed 65, the present one lists 120). The position of numerous species then in doubt has since been cleared up and many of the question marks have been removed, this being the case especially with the North American species described by Osborn, almost all of which were then in doubt but have since been cleared up. More significant, perhaps, than the description of new genera and species is the improved standard of work that has been established. The magnificent "Monographie der Robbenlaüse" of Enderlein, in the report of the "Deutsche Südpolar Expedition," and the careful and critical work of Fahrenholz, Cummings, and Neumann, form a splendid contrast to the superficial and often inaccurate work that formerly prevailed.

The synonymy of many of the hosts and some of the parasite species is still badly tangled. The hosts have frequently been referred to only by their vernacular names and when the scientific names have been used they have sometimes been inaccurate, added to which the instability of mammal nomenclature has not been conducive to clearness. The synonymy of the North American mammals has in part been worked out from the "List of North American Land Mammals in the United States National Museum" (Miller, 1911), and, in ad-

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dition, the authorities of the Museum of Vertebrate Zoology of the University of California have been extremely kind in helping to clear up numerous matters. The synonymy of the European mammals has been worked out from the "Catalogue of the Mammals of Europe" (Miller, 1912). The synonymy of the Primates has been taken from Elliot's "A Review of the Primates" (1912), but it is very probably still far from correct. The synonymy of other species, when not obtainable elsewhere, has been reduced to the basis of Trouessart's "Catalogus Mammalium" (1899), although it has been necessary to do this only in the case of some of the older species. The host names given in the list of Anoplura are as nearly as can be determined the correct ones. In the host list the names in parentheses are regarded as synonyms, the others are correct as far as available information permits. An attempt has been made to list all the host names that have at any time been used.

SYSTEMATIC POSITION OF THE ANOPLURA

Anoplura Leach, Edinburgh Encyclopedia (1817); Enderlein, Zool. Anz., vol. 28, pp. 121-147 (1904); Mjöberg, Ark. f. Zool., vol. 6, pt. 13 (1910); Cummings, An. Mag. Nat. Hist., ser. 8, vol. 15, pp. 256-259 (1915).

Pediculinæ Burmeister, Handbuch d. Ent., vol. 2, p. 52 (1835).

Siphunculata Meinert, Videnskabelige Meddelelser (1896); Cholodkovsky, Zool. Anz., vol. 27, p. 527 (1904).

Pseudorhyncota Cholodkovsky, Zool. Anz., vol. 27, p. 125 (1903).

Lipognatha Börner, Zool. Anz., vol. 27, p. 527 (1904).

Ellipoptera Shipley, ibid., vol. 27, p. 261 (1904).

The systematic position of the Anoplura has always been a matter of doubt and dispute. Because of their parasitic habits they were for a long time classed with the Mallophaga, but later under the influence of the "biting- or sucking-mouth-parts" fetish, the two groups were separated and the Anoplura were placed with the Hemiptera, of which they have for some time been regarded as a suborder most frequently known as Parasita. Their position here has quite generally been re-

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garded as rather definitely fixed, but within the last few years evidence has been found which indicates that a readjustment is again desirable.

Handlirsch and Cholodkovsky have favored an arrangement which restores the Anoplura and Mallophaga to a position very similar to that which they originally held in relation to each other, and other authors have brought forward evidence in support of this view. As a result of a comparative study of the two groups Mjöberg has concluded that they are really quite closely related, the Anoplura being merely a further adaptation to a parasitic life, and with this view Kellogg and Cummings are inclined to agree. Enderlein alone, of recent authors, has contended for retaining the Anoplura as a suborder of Hemiptera. The evidence is too voluminous to be reviewed here, but it indicates very strongly that the Anoplura really have nothing to do with the Hemiptera and are related to the Mallophaga. It seems best to regard the Anoplura as a distinct order and in the latest classification of the Insecta, that of Brues and Melander, this is done. However, the problem of their relationships is still an open question which can only be settled by much more careful comparative morphological studies.

The classification within the order itself is extremely simple; too little is known about the group for the classification to be otherwise. Four families, all of which apparently form quite natural groups, are recognized. Of these, one, Hæmatomyzidæ, contains a single remarkable species (with a possible variety) which occurs upon elephants. Another small family, Echinophthiriidæ, is limited in its occurrence to marine mammals, its peculiarities being ascribable to adaptation to the aquatic life of the hosts. The Pediculidæ include the species found upon man, apes and monkeys, and the remainder of the species are contained in the family Hæmatopinidæ.

Nearly as many species have been described since 1908 as had been described previous to that time, but in spite of this activity the study of the group has hardly begun. The host list, when compared with a list of the mammals of the world, is pitifully small, as is instanced by the fact that there are but four records of Anoplura from mammals of the South Ameri-

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can region. It is certainly not unsafe to estimate that the number of known species is not more than one-fifth of those that actually exist.

KEY

To Families, Subfamilies and Genera of Anoplura.

1—Body thickly beset with more or less short, stout spines, or with spines and scales. Occurring exclusively on marine mammals. Family Echinophthiriidæ..... 2

Body with spines or hairs always in definite rows, never with scales. Occurring exclusively on land mammals 4

2—Thorax and abdomen bearing delicate scales. Antennæ four- or five-segmented. Subfamily Antarctophthiriinæ 3

Thorax and abdomen without scales. Antennæ four-segmented.

Subfamily Echinophthiriinæ..Genus *Echinophthirius*

3—Antennæ four-segmented.....Genus *Lepidophthirus*

Antennæ five-segmented.....Genus *Antarctophthirus*

4—Head tubularly produced anteriorly; tibiæ without a thumb-like process opposing the claw. Family Hæmatomyzidæ. One genus, *Hæmatomyzus*, occuring on elephants.

Head not so produced; tibiæ with thumb-like process opposing the claw..... 5

5—Eyes lacking. Family Hæmatopinidæ..... 9

Eyes present, well pigmented. Occurring on man, apes and monkeys. Family Pediculidæ..... 6

6—Antennæ distinctly five-segmented, abdomen without pleural plates. Subfamily Pediculinæ..... 8

Antennæ three-segmented or obscurely five-segmented, abdomen with pleural plates. Subfamily Pedicininæ 7

7—Legs all with slender, pointed claws, abdomen with three pairs of pleural plates.....Genus *Pedicinus*

Anterior legs with slenderer claw than the others, abdomen with two pairs of pleural plates.....

.....Genus *Phthirpedicinus*

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8—Legs all of same size.....Genus *Pediculus*
Anterior legs much smaller than others...Genus *Phthirus*
9—Antennæ five-segmented.....11
Antennæ three-segmented. Subfamily Euhæmatopininæ 10
10—Posterior legs with stalked, disk-shaped appendages on femur and tibia.....Genus *Euhæmatopinus*
Posterior legs without such appendages.....
..... Genus *Hæmatopinoides*
11—Legs and claws all practically of equal size.....
Subfamily Hæmatopininæ.....Genus *Hæmatopinus*
Anterior legs smaller and with slenderer claw than the posterior pair, at least. Subfamily Linognathinæ..12
12—Anterior tarsi with two joints.....Genus *Hybophthirus*
Anterior tarsi with but one joint.....13
13—Anterior tarsi with a short, claw-like process in addition to the claw.....Genus *Scipio*
Anterior tarsi not so.....14
14—Abdomen with well developed pleural plates.....18
Abdomen entirely without pleural plates.....15
15—Abdomen with more than one row of hairs or spines on each segment.....Genus *Linognathus*
Abdomen with but one row of hairs on each segment..16
16—Gonapods moderately long, behind each gonapod a stout, flat, spine-like process.....Genus *Cervophthirius*
Gonapods very short, no flat, spine-like process behind them.....Genus *Hæmodipsus* (in part)
18—Anterior pair of legs equal to middle pair, both pairs very small, posterior pair large and stout.....
.....Genus *Enderleinellus*
Anterior legs smaller than either middle and posterior legs and with much smaller and more slender claw.19
19—Second or third abdominal sternite with a chitinized plate or area near each lateral margin.Genus *Fahrenholzia*
Second or third abdominal sternite without such plates 20
20—Abdominal segments with but a single transverse row of spines.....21
Abdominal segments, at least in part, with two or more transverse rows of spines.....22

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21—Occiput deeply sunk into the thorax, rostrum surrounded by denticles, pleural plates quite large.....
.....Genus *Eulinognathus*
Occiput not deeply sunk into the thorax, rostrum not surrounded by denticles, pleural plates minute....
.....Genus *Hæmodipsus* (in part)

22—Abdominal tergites and sternites with not more than two rows of hairs or spines.....23
Abdominal tergites and sternites in part with three rows of hairs or spines.....Genus *Hoplopleura*

23—First antennal segment with a short, stout spine at the distal post axial angle or on the posterior margin.....
.....Genus *Neohæmatopinus* (in part)
First antennal segment not so.....24

24—Posterior margin of second abdominal tergite of male distinctly emarginate with a group of spines at each end of this emargination...Genus *Neohæmatopinus* (in part)
Posterior margin of second abdominal tergite of male not thus emarginate.....25

25—Abdomen with distinct, chitinized tergal and sternal plates in both sexes.....Genus *Polyplax*
Abdomen without distinct, chitinized tergal and sternal plates in the female and with these absent or extremely reduced in size in the male..Genus *Linognathoides*

Family *Pediculidæ*

Leach, Zool. Misc., Vol. 3, p. 64 (1817); Giebel, Insecta Epizoa, p. 21 (1874); Piaget, Les Ped., pp. 615-618 (1880); Enderlein, Zool. Anz., Vol. 28, p. 136 (1904); Dalla Torre, Gen. Ins., Anopl., p. 8 (1908).

Antennæ five- or three- (obscurely five-) segmented. Eyes present, distinctly pigmented. Legs fitted for climbing, the tibiæ with a thumb-like process opposing the claw. No pretarsal sclerite between tibia and tarsus. Parasitic upon man, apes, and monkeys.

Subfamily *Pediculinæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins., Anopl., p. 8 (1908).

Antennæ distinctly five-segmented. No pleural plates.

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Genus *Pediculus* Linnæus

Linnæus, Systema Naturæ, ed. 10, p. 610 (1758); Denny, Mon. Anopl., pp. 12-13 (1842); Giebel, Ins. Epizoa, pp. 27-30 (1874); Piaget, Les Ped., pp. 619-623 (1880); Enderlein, Zool. Anz:, Vol. 28, pp. 136, 138 (1904).

Head short. Legs all of approximately the same size. Abdomen elongated. Spiracles small. Abdominal segments without lateral projections, and with numerous small spines.

Type of the genus *P. capitis* De Geer.

1—*Pediculus mjöbergi,* new name. From *Ateleus* sp.? (traveling menagerie, Europe).

1910. *Pediculus affinis* (not of Burmeister), Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 169-171, f. 85.

2—*Pediculus capitis* De Geer. From man. Also recorded from *Ateleus ater* (locality unknown) and from *Cebus fatuellus* and *Cebus* sp. (Rio de Janeiro, S. America).

1758. *Pediculus humanus* Linnæus, Syst. Naturæ, 10th ed., p. 610.

1778. *Pediculus humanus* var. I, Linnæus, ibid., 12th ed., Vol. 2, p. 1016.

1778. *Pediculus humanus* var. *capitis* De Geer, Mem. Hist. Ins., Vol. 7, p. 67; pl. 1, f. 6.

1817. *Pediculus cervicalis* Leach, Zool. Misc., Vol. 3, p. 66.

1818. *Pediculus capitis* Nitzsch, Germar's Mag., Vol. 3, p. 305.

1842. *Pediculus capitis* Denny, Mon. Anopl., pp. 13-16; pl. 26, f. 2.

1874. *Pediculus capitis* Giebel, Ins. Epizoa, pp. 30-32; pl. 1, f. 1-2.

1880. *Pediculus capitis* Piaget, Les Ped., pp. 619-623; pl. 50, f. 2.

1912. *Pediculus capitis* Fahrenholz, Jahresb. d. Niedersäch. Zool. Ver., pp. 2-12:t. f. 1, 3, 7, pl. 3, f. 3-4.

3—*Pediculus consobrinus* Piaget. From *Ateleus paniscus* (Museum Leyden).

1880. *Pediculus consobrinus* Piaget, Les. Ped., pp. 626-628; pl. 51, f. 4.

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1908. *Pediculus consobrinus* Dalla Torre, Gen. Ins. Anopl., p. 8.

1911. *Pediculus consobrinus* Neumann, Arch. de Par., Vol. 14, pp. 412-413.

NOTE: This species is very doubtfully distinct from *Pediculus capitis.*

4—*Pediculus corporis* De Geer. From man.

1758. *Pediculus humanus* Linnæus, Syst. Nat., 10th ed., p. 610.

1766. *Pediculus humanus* var. 2 Linnæus, ibid., 12th ed., Vol. 2, p. 1016.

1778. *Pediculus humanus* var. *corporis* De Geer, Mem. Hist. Ins., Vol. 7, p. 67; pl. 1, f. 7.

1818. *Pediculus vestimenti* Nitzsch, Germar's Mag., Vol. 3, p. 305.

1842. *Pediculus vestimenti* Denny, Mon. Anopl., pp. 16-18; pl. 26, f. 1.

1874. *Pediculus vestimenti* Giebel, Ins. Epizoa, pp. 27-30; pl. 1, f. 5.

1880. *Pediculus vestimenti* Piaget, Les. Ped., pp. 623-625; pl. 5, f. 3.

1908. *Pediculus corporis* Dalla Torre, Gen. Ins., Anopl., p. 8.

1911. *Pediculus capitis* var. *vestimenti* Neumann, Arch. de Par., Vol. 14, pp. 411-412.

1912. *Pediculus corporis* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 2-12; f. 2; pl. 3, f. 1-2.

5—*Pediculus lobatus* Fahrenholz. From *Ateleus pan* (Berlin Museum).

1913. *Pediculus lobatus* Fahrenholz (without description), Zool. Anz., Vol. 41, p. 373.

6—*Pediculus oblongus* Fahrenholz. From *Hylobates concolor* and *Hylobates syndactylus.*

1913. *Pediculus oblongus* Fahrenholz (without description), Zool. Anz., Vol. 41, p. 373.

7—*Pediculus schäffi* Fahrenholz. From *Pan* sp.?

1910. *Pediculus schäffi* Fahrenholz, Zool. Anz., Vol. 35, p. 714.

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Genus *Phthirus* Leach

Phthirus Leach, Edinburgh Encycl., Vol. 9, p. 77 (1815); Zool. Misc., Vol. 3, p. 64 (1817); Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins., Anopl., p. 9 (1908).

Phthirius Burmeister, Handbuch der Entomologie, Vol. 2, p. 1 (1835); Denny, Mon. Anopl., pp. 8-9 (1842); Giebel, Ins. Epizoa, pp. 23-27; pl. 1, f. 8 (1874); Piaget, Les Ped., pp. 628-630; pl. 51, f. 5 (1880).

Anterior legs much smaller and with much slenderer claws than the others. Abdomen short and broad, the fifth to eighth segments with conical lateral processes. Spiracles large, those of the first three abdominal segments crowded close together.

1—*Phthirus pubis* Linnæus. From man.

1758. *Pediculus pubis* Linnæus, Syst. Naturæ, ed. 10, p. 611.
1817. *Phthirus inguinalis* Leach, Edinburgh Encycl., Vol. 9, p. 77.
1818. *Pediculus tabescentium* Alt. De Phthiriasi.
1842. *Phthirius inguinalis* Denny, Mon. Anopl., pp. 9-11; pl. 26, f. 3.
1874. *Phthirius inguinalis* Giebel, Ins. Epizoa, pp. 23-27; pl. 1, f. 8.
1880. *Phthirius inguinalis* Piaget, Les Ped., pp. 628-630; pl. 51, f. 5.
1904. *Phthirus pubis* Enderlein, Zool. Anz., Vol. 28, p. 136.
1908. *Phthirus pubis* Dalla Torre, Gen. Ins., Anopl., p. 9.

Subfamily *Pedicininæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins., Anopl., p. 9 (1908); Fahrenholz, Jahresb. d. Niedersäch. Zool. Ver., pp. 28-29 (1912).

Antennæ three-segmented or obscurely five-segmented. Head more or less elongated. Abdomen with a single row of many very small spines on each segment. Pleural plates present on certain abdominal segments.

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NOTE: The synonymy of the species in this subfamily has been dealt with by Fahrenholz and, although it is still far from clear, his conclusions have been adopted here.

Genus *Pedicinus* Gervais

Gervais, Aptères, Vol. 3, p. 301; pl. 48, f. 1 (1844); Giebel, Ins. Epizoa, pp. 32-33 (1874); Piaget, Les Ped., pp. 630-632 (1880); Dalla Torre, Gen. Ins., Anopl., p. 9 (1908); Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 12-16 (1912).

All legs with slender, pointed claws of nearly the same size. Abdomen with three pairs of pleural plates.

Type of the genus *Pedicinus eurygaster* Piaget.

1—*Pedicinus breviceps* Piaget. From *Lasiopyga mona.* Also from *Cercopithecus,* sp., and *Pithecus albibarbatus.*

1880. *Pedicinus breviceps* Piaget, Les Ped., pp. 632-633; pl. 52, f. 1.

1910. *Pedicinus breviceps* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 172.

1912. *Pedicinus breviceps* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., p. 16, 28.

2—*Pedicinus eurygaster* (Burmeister). From *Pithecus nemestrinus* and *Pithecus fascicularis?*

1838. *Pediculus eurygaster* Burmeister, Gen. Insectorum.

1880. *Pedicinus eurygaster* Piaget, Les Ped., p. 630; pl. 51, f. 6.

1908. *Pedicinus eurygaster* Dalla Torre, Gen. Ins., Anopl., p. 9.

1912. *Pedicinus eurygaster* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 12-15, 28.

3—*Pedicinus hamadryas* Mjöberg. Type from *Papio* sp.? (Zool. Mus. Hamburg).

1910. *Pedicinus hamadryas* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 172-174, f. 86-87.

4—*Pedicinus longiceps* Piaget. Type from *Pygathrix cristata?* Also from *Pithecus fascicularis?*

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1880. *Pedicinus longiceps* Piaget, Les Ped., p. 632; pl. 51, f. 7.
1908. *Pedicinus longiceps* Dalla Torre, Gen. Ins., Anopl., p. 9.
1912. *Pedicinus longiceps* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 15, 28.

5—*Pedicinus parallelicеps* Mjöberg. From *Pithecus albibarbatus* (Zool. Mus. Hamburg).

1910. *Pedicinus parallelicеps* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 174-176, f. 88.

6—*Pedicinus rhesi* Fahrenholz. From *Pithecus rhesus.*

1912. *Pedicinus rhesi* Fahrenholz, Zool. Anz., Vol. 39, p. 54.
1912. *Pedicinus rhesi* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 15-22; pl. 1, f. 4, 5; pl. 3, f. 6

Genus *Phthirpedicinus* Fahrenholz

Fahrenholz, Zool. Anz., Vol. 39, pp. 54-55 (1912), 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 22-23.

Anterior legs with slender, pointed claw, others with short, blunt claws. Abdomen with two pairs of pleural plates.

Type of the genus *Phthirpedicinus micropilosus* Fahrenholz.

1—*Phthirpedicinus micropilosus* Fahrenholz. From *Pithecus rhesus.*

1912. *Phthirpedicinus micropilosus* Fahrenholz, Zool. Anz., Vol. 39, p. 55.
1912. *Phthirpedicinus micropilosus* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 22-23; pl. 1, f. 1-3.

2—*Phthirpedicinus microps* (Nitzsch). From *Pithecus sinicus.*

1838. *Pediculus eurygaster* Burmeister, Gen. Ins.
1864. *Pediculus microps* Nitzsch, Giebel, Zeit. f. ges. Naturw., Vol. 23, p. 32.
1874. *Pedicinus eurygaster* Giebel, Ins. Epizoa, pp. 32-33.
1912. *Phthirpedicinus microps* Fahrenholz, Zool. Anz., Vol. 39, p. 55.

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1912. *Phthirpedicinus microps* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 13, 26, 28.

3—*Phthirpedicinus piageti* (Stroebelt). From *Pithecus brevicaudatus* or *P. rhesus.*

1881. *Pedicinus piageti* Stroebelt, Jahresb. d. westf. Ver. f. Wissensch. u. Kunst, Vol. 9, p. 82; pl. 1, f. 3.

1908. *Pedicinus piageti* Dalla Torre, Gen. Ins., Anopl., p. 9.

1912. *Phthirpedicinus piageti* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., p. 28.

Pediculidæ of uncertain position

Pedicinus graciliceps Piaget. From unknown host.

1885. *Pedicinus graciliceps* Piaget, Les Ped., Suppl., p. 141; pl. 15, f. 4.

1912. *Pedicinus? graciliceps* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 20, 29.

NOTE: Fahrenholz regards this species as probably belonging to an undescribed genus, characterized chiefly by the presence of five pairs of pleural plates.

Hæmatopinus albidus Rudow. From *Simia sylvanus.*

1869. *Hæmatopinus albidus* Rudow, Zeit. f. d. ges. Naturw., Vol. 34, p. 169.

1912. *Hæmatopinus? albidus* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., p. 29.

NOTE: Judging from the host, this probably belongs to the subfamily *Pedicininæ.* The genus cannot be determined.

Hæmatopinus obtusus Rudow. From *Pygathrix aurata?*

1869. *Hæmatopinus obtusus* Rudow, Zeit. f. d. ges. Naturw., Vol. 34, p. 169.

1908. *Hæmatopinus? obtusus* Dalla Torre, Gen. Ins., Anopl., p. 11.

NOTE: This probably belongs to the *Pediculidæ.*

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Family *Hæmatopinidæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 137 (1904); Dalla Torre, Gen. Ins., Anopl., p. 10 (1908).

Eyes lacking. Antennæ three- or five-segmented. Tibiæ with a thumb-like process opposing the claw.

Subfamily *Hæmatopininæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins., Anopl., p. 10 (1908).

Antennæ five-segmented. Anterior legs of practically the size of the others. A triangular skeletal piece (pre-tarsal sclerite) present between tibia and tarsus.

Genus *Hæmatopinus* Leach

Leach, Zool. Misc., Vol. 3, pp. 64-65, f. 146 (1817); Denny, Mon. Anopl., pp. 24-25 (1842); Giebel, Ins. Epizoa, pp. 33-35 (1874); Piaget, Les Ped., pp. 633-635 (1880); Enderlein, Zool. Anz., Vol. 28, p. 138 (1904); Neumann, Arch. de Par., Vol. 13, pp. 529-532 (1909); Dalla Torre, Gen. Ins., Anopl., p. 10 (1908); Kellogg & Ferris, Anopl. and Mall., p. 10 (1915).

Head with very sharp, forward pointing temporal angles. Thorax broad. Legs all of practically the same size, with a strongly chitinized skeletal piece between tibia and tarsus. Abdomen with a swollen, pad-like, chitinized area on the lateral margins of the third to eighth segments. Tergites and sternites with a varying number of small chitinized plates. Each tergite and sternite with one transverse row of very small hairs.

Recorded from *Perissodactyla* and *Artiodactyla.*

Type of the genus, *Hæmatopinus suis* (Linnæus).

1—*Hæmatopinus asini* (Linnæus). From the domestic horse and the ass (cosmopolitan). Also from *Equus burchelli* (Zool. Mus. Hamburg).

1758. *Pediculus asini* Linnæus, Syst. Nat., 10th ed., p. 612.

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1829. *Hæmatopinus asini* Stephens, Catalogue, Vol. 2, p. 329.
1838. *Pediculus macrocephalus* Burmeister, Gen. Rhyn. No. 18.
1842. *Hæmatopinus asini* Denny, Mon. Anopl., pp. 32-33; pl. 25, f. 1.
1865. *Hæmatopinus equi* Simmonds, Journ. Ag. Soc. Lond. (2), Vol. 1, pp. 60-62.
1874. *Hæmatopinus macrocephalus* Giebel, Ins. Epizoa, pp. 44-45; pl. 2, f. 5.
1880. *Hæmatopinus macrocephalus* Piaget, Les Ped., pp. 652-653; pl. 53, f. 3.
1891. *Hæmatopinus asini* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 21-22, f. 9.
1896. *Hæmatopinus asini* Osborn, Bul. 5, n. s., pp. 180-181, f. 103.
1904. *Hæmatopinus asini* Enderlein, Zool. Anz., Vol. 28, p. 141.
1908. *Hæmatopinus asini* Dalla Torre, Gen. Ins., Anopl., p. 10.
1910. *Hæmatopinus asini* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 167.

1a—*Hæmatopinus asini* var. *colorata* Piaget. From *Equus asinus*. (Europe).
1880. *Hæmatopinus macrocephalus* var. *colorata* Piaget, Les Ped., p. 654.

2—*Hæmatopinus bufali* (De Geer). From *Buffelus caffer*. (Congo Free State and Nyasaland, Africa).
1778. *Pediculus bufali* De Geer, Histoire des Ins., Vol. 7, p. 68; pl. 1, f. 11, 12.
1844. *Pediculus phthiriopsis* Gervais, Apteres, Vol. 3, p. 306.
1874. *Hæmatopinus phthiriopsis* Giebel, Ins. Epizoa, p. 47.
1880. *Hæmatopinus phthiriopsis* Piaget, Les Ped., p. 652.
1904. *Hæmatopinus phthiriopsis* Enderlein, Zool. Anz., Vol. 28, p. 141.
1908. *Hæmatopinus phthiriopsis* Dalla Torre, Gen. Ins., Anopl., p. 11.

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1909. *Hæmatopinus bufali* Neumann, Arch. de Par., Vol. 13, pp. 500-505, f. 2-5.

1910. *Hæmatopinus phthiriopsis* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 166.

3—*Hæmatopinus eurysternus* (Nitzsch). From *Bos taurus.*

1818. *Pediculus eurysternus* Nitzsch, Germar's Mag., Vol. 3, p. 305.

1842. *Hæmatopinus eurysternus* Denny, Mon. Anopl., pp. 29-30; pl. 25, f. 5.

1864. *Pediculus eurysternus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 27.

1874. *Hæmatopinus eurysternus* Giebel, Ins. Epizoa, pp. 41-42; pl. 2, f. 8.

1880. *Hæmatopinus eurysternus* Piaget, Les Ped., pp. 648-650; pl. 53, f. 1.

1885. *Hæmatopinus tuberculatus* var. *penicillatus* Piaget, Les Ped., Suppl., p. 146.

1891. *Hæmatopinus eurysternus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 13-16, f. 6.

1896. *Hæmatopinus eurysternus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 172-175, f. 100.

1908. *Hæmatopinus eurysternus* Dalla Torre, Gen. Ins., Anopl., p. 11.

1909. *Hæmatopinus eurysternus* Neumann, Arch. de Par., Vol. 13, l.c., pp. 498-500.

4—*Hæmatopinus longus* Neumann. From *Cervus unicolor.* (Nepaul, India).

1912. *Hæmatopinus longus* Neumann, Bul. Soc. Zool. France, Vol. 37, pp. 141-142, f. 1-4.

5—*Hæmatopinus* ? *oviformis* Rudow. From *Hircus magnificus.*

(This name does not appear in available catalogues of mammals).

1869. *Hæmatopinus oviformis* Rudow, Zeit. f. ges. Naturw., Vol. 34, p. 170.

1874. *Hæmatopinus oviformis* Giebel, Ins. Epizoa, p. 47.

1880. *Hæmatopinus oviformis* Piaget, Les Ped., p. 648.

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1908. *Hæmatopinus? oviformis* Dalla Torre, Gen. Ins., Anopl., p. 11.

6—*Hæmatopinus phachochoeri* Enderlein. Type from *Phachochoerus oeliani massaicus.* (Kilimandjaro). Also from *Phachochoerus,* sp., *Potamochoerus choeropotamus* and *P. africanus, P. affinis nyasæ.* (German E. Africa and S. Africa).

1908. *Hæmatopinus phachochoeri* Enderlein, Swed. Exp. Kilimandjaro-Meru, Vol. 2, pt. 11, pp. 7-9, fig.

1909. *Hæmatopinus latus* Neumann, Arch. de Par., Vol. 13, pp. 505-508, f. 6-9.

1911. *Hæmatopinus peristictus* Kellogg & Paine, Bul. Ent. Res., Vol. 2, pp. 145-146; pl. 4, f. 3-6.

1912. *Hæmatopinus phachochoeri* Paine, Ent. News, Vol. 23, p. 468.

1912. *Hæmatopinus phachochoeri* Harms, Zool. Anz., Vol. 40, p. 293, f. 3.

1912. *Hæmatopinus incisus* Harms, Ibid., pp. 290-292, f. 12.

1916. *Hæmatopinus phachochoeri* Ferris, Ann. Durban Mus., Vol. 2 (in press).

NOTE: This possibly contains two species; if so, they should stand as *Hæmatopinus phachochoeri* Enderlein and *Hæmatopinus peristictus* Kellogg & Paine.

7—*Hæmatopinus punctatus* (Rudow). From *Bos grunniens.*

1869. *Pediculus punctatus* Rudow, Zeit. f. ges. Naturw., Vol. 34, p. 167.

1874. *Hæmatopinus punctatus* Giebel, Ins. Epizoa, p. 47.

1880. *Hæmatopinus tuberculatus* var. *punctatus* Piaget, Les Ped., p. 652.

1908. *Pediculus? punctatus* Dalla Torre, Gen. Ins., Anopl., p. 9.

1910. *Hæmatopinus punctatus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 166-167.

8—*Hæmatopinus suis* (Linnæus). From domestic swine. (Cosmopolitan).

1634. *Pediculus urius* Moufet, Theatrum Ins., p. 266.

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1758. *Pediculus suis* Linnæus, Syst. Nat. (10th ed.), p. 611.
1817. *Hæmatopinus suis* Leach, Zool. Misc., Vol. 3, p. 65; pl. 146.
1818. *Pediculus urius* Nitzsch, Germar's Mag., Vol. 3, p. 305.
1842. *Hæmatopinus suis* Denny, Mon. Anopl., pp. 34-35; pl. 25, f. 2.
1847. *Hæmatopinus suis* Burmeister, Linnea. Entomol., Vol. 2, p. 577; pl. 1.
1874. *Hæmatopinus urius* Giebel, Ins. Epizoa, pp. 45-46; pl. 2, f. 6.
1880. *Hæmatopinus urius* Piaget, Les Ped., pp. 654-656; pl. 48, f. 4.
1891. *Hæmatopinus urius* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 18-21, f. 8.
1896. *Hæmatopinus urius* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 178-180, f. 102.
1904. *Hæmatopinus suis* Enderlein, Zool. Anz., Vol. 28, p. 124.
1908. *Hæmatopinus suis* Dalla Torre, Gen. Ins., Anopl., p. 11.
1911. *Hæmatopinus suis* Neumann, Arch. de Par., Vol. 14, pp. 406-490, f. 8a.

8a—*Hæmatopinus suis* var. *adventicius* Neumann. From *Sus vittatus* (East Indies).

1911. *Hæmatopinus suis* var. *adventicius* Neumann, Arch. de Par., Vol. 14, pp. 406-410, f. 8b.

9—*Hæmatopinus taurotragi* Cummings. From *Taurotragus oryx*. (Menagerie, Eng.)

1914. *Hæmatopinus taurotragi* Cummings, Bul. Ent. Res., Vol. 5, pp. 155-159, f. 1-2.

10—*Hæmatopinus tuberculatus* (Burmeister). Type from "Common buffalo or buffalo of India" (Vienna), also from "Buffalo of India, Tonkin, Summatra and Rumania," *Bison bison* (North America), *Camelus dromedarius* (India) and African camels.

1668. *Piddochio del cammello* Redi, Esperienze intorno alla generatione degl' insetti, pl. 20.

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1758. *Pediculus cameli* Linnæus, Systema Naturæ, ed. 10, p. 611.
1839. *Pediculus tuberculatus* Burmeister, Gen. Rhyn., No. 20.
1844. *Pediculus cameli* Gervais, Apteres, Vol. 3, p. 306.
1852. *Hæmatopinus tuberculatus* Lucas, Ann. Ent. Soc. France, Vol. 10, ser. 2, pp. 529-533; pl. 11, No. 2.
1864. *Pediculus tuberculatus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 32.
1867. *Hæmatopinus tuberculatus* Nitzsch, Ibid., Vol. 28, p. 397.
1874. *Hæmatopinus cameli* Giebel, Ins. Epizoa, p. 47.
1874. *Hæmatopinus tuberculatus* Giebel, Ibid., pp. 46-47.
1880. *Hæmatopinus cameli* Piaget, Les Ped., p. 644.
1880. *Hæmatopinus tuberculatus* Piaget, Ibid., pp. 650-652; pl. 53, f. 2.
1904. *Hæmatopinus tuberculatus* Enderlein, Zool. Anz., Vol. 28, p. 140.
1908. *Hæmatopinus? cameli* Dalla Torre, Gen. Ins., Anopl., p. 11.
1908. *Hæmatopinus tuberculatus* Dalla Torre, Ibid., p. 11.
1909. *Hæmatopinus tuberculatus* Neumann, Arch. de Par., Vol. 13, pp. 497-500, f. 1.
1910. *Hæmatopinus tuberculatus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 167.
1911. *Hæmatopinus tuberculatus* Neumann, Arch. de Par., Vol. 14, pp. 413-414.

Subfamily *Linognathinæ*.

Trichaulinæ Enderlein, Zool. Anz., Vol. 28, p. 138 (1904).

Linognathinæ Enderlein, Zool. Anz., Vol. 29, p. 194 (1905); Dalla Torre, Gen. Ins., Anopl., p. 11 (1908).

Antennæ five-segmented. Anterior legs always distinctly smaller and with much slenderer claw than the posterior. No skeletal piece (pre-tarsal sclerite) between tibia and tarsus.

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Genus *Enderleinellus* Fahrenholz

Fahrenholz, Zool. Anz., Vol. 39, p. 56 (1912); 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 52-58 (1912); Kellogg and Ferris, Anopl. & Mall. of N. Am. Mam., p. 40 (1915).

Anterior and middle pairs of legs of equal size, small and with slender claws. Posterior legs very large and stout, with stout claw. Head entirely without temporal angles. Abdomen with or without chitinized tergal and sternal plates. Abdominal segments for the most part with but one row of hairs or spines in both male and female. Third sternite usually with a widely separated pair of chitinized plates or areas, one near each lateral margin. Pleurites present on second to fifth or sixth segments.

Recorded only from *Sciuridæ* and *Petauristidæ* (Rodentia).

Type of the genus *Enderleinellus sphærocephalus* (Nitzsch).

1—*Enderleinellus kelloggi* Ferris. Type from *Sciurus griseus nigripes* (California, U. S. A.). Also from *S. griseus griseus* (California).

1916. *Enderleinellus kelloggi* Ferris, Psyche, Vol. 23 (in press).

2—*Enderleinellus longiceps* Kellogg & Ferris. Type from *Sciurus niger rufiventer* or *S. carolinensis* (Lincoln, Nebraska, U. S. A.) Also from *Sciurus niger rufiventer* (Indiana, U. S. A.) and *S. arizonensis huachuca* (Arizona, U. S. A.).

1915. *Enderleinellus longiceps* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 44-46; pl. 2, f. 5; pl. 4, f. 12; pl. 6, f. 2.

1916. *Enderleinellus longiceps* Ferris, Psyche, Vol. 23 (in press).

3—*Enderleinellus osborni* Kellogg & Ferris. Type from *Citellus beecheyi* (California, U. S. A.). Also from *Citellus douglasi* (California).

1915. *Enderleinellus osborni* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 43-44; t. f. 15; pl. 4, f. 11; pl. 6, f. 6.

4—*Enderleinellus sphærocephalus* (Nitzsch). Type from *Sciurus vulgaris* (Europe). Also from *Sciurus hudsonicus*

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petulans and *S. hudsonicus vancouverensis* (Alaska) and *S. douglasi albolimbatus* (California, U. S. A.).

1818. *Pediculus sphærocephalus* Nitzsch, Germar's Mag., Vol. 3, p. 305.
1842. *Hæmatopinus sphærocephalus* Denny, Mon. Anopl., p. 36.
1864. *Pediculus sphærocephalus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 27.
1874. *Hæmatopinus sphærocephalus* Giebel, Ins. Epizoa, pp. 35-36; pl. 1, f. 4.
1880. *Hæmatopinus sphærocephalus* Piaget, Les Ped., p. 640-641.
1904. *Polyplax ? sphærocephala* Enderlein, Zool. Anz., Vol. 28, p. 143.
1908. *Polyplax ? sphærocephala* Dalla Torre, Gen. Ins., Anopl., p. 14.
1910. *Polyplax ? sphærocephala* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 159-160.
1912. *Enderleinellus sphærocephalus* Fahrenholz, Zool. Anz., Vol. 39, p. 56.
1912. *Enderleinellus sphærocephalus* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 52-53, f. 22-23; pl. 2, f. 5, 6, 7.
1916. *Enderleinellus sphærocephalus* Ferris, Psyche, Vol. 23 (in press).

5—*Enderleinellus suturalis* (Osborn). Type from *Citellus franklini* or *C. tridecemlineatus* (Iowa). Also from *C. oregonus* and *C. mollis* (Nevada, U. S. A.), *C. townsendi* (Washington, U. S. A.), *Citellus beldingi, Xerospermophilus tereticaudus* and *Ammospermophilus nelsoni* (California, U. S. A.), *Cynomys gunnisoni* and *C. leucurus* (Colorado, U. S. A.).

1891. *Hæmatopinus suturalis* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 27, f. 15.
1896. *Hæmatopinus suturalis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 185, f. 109.
1904. *Polyplax ? suturalis* Enderlein, Zool. Anz., Vol. 28, p. 143.
1908. *Polyplax ? suturalis* Dalla Torre, Gen. Ins., Anopl., p. 14.

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1915. *Enderleinellus suturalis Kellogg* & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 40-42; pl. 4, f. 9.

1916. *Enderleinellus suturalis* Ferris, Psyche, Vol. 23 (in press).

5a—*Enderleinellus suturalis* var. *occidentalis* Kellogg & Ferris. From *Callospermophilus chrysodeirus trinitatus* (California, U. S. A.).

1915. *Enderleinellus suturalis* var. *occidentalis* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 42; pl. 2, f. 3; pl. 4, f. 10; pl. 5, f. 17.

6—*Enderleinellus uncinatus* Ferris. From *Glaucomys sabrinus lascivus* (California, U. S. A.).

1916. *Enderleinellus uncinatus* Ferris, Psyche, Vol. 23 (in press).

Genus *Fahrenholzia* Kellogg & Ferris

Kellogg and Ferris, Anopl. and Mall. of N. Am. Mam., p. 32.

Antennæ similar in sexes. Head and thorax very small. Anterior legs small with slender claw. Middle and posterior legs much larger, sub-equal, with stout claws. Abdomen without chitinized tergal and sternal plates. Each abdominal segment with but one row of spines in both male and female. Pleural plates present on a variable number of segments. Sternite of second segment with a large chitinized plate near each lateral margin. Spiracles small.

Recorded only from *Heteromyidæ* (Rodentia).

Type of the genus *Fahrenholzia pinnata* Kellogg & Ferris.

1—*Fahrenholzia pinnata* Kellogg & Ferris. Type from *Dipodomys californicus* (California, U. S. A.). Also from *Dipodomys deserti, D. merriami, Perodipus* sp. and *Microdipodops polionotus* (California) and *Perognathus parvus olivaceous* (Nevada, U. S. A.).

1915. *Fahrenholzia pinnata* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 32-35; t. f. 13; pl. 3, f. 2; pl. 5, f. 5-6; pl. 6, f. 10.

1916. *Fahrenholzia pinnata* Ferris, Psyche, Vol. 23 (in press).

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2—*Fahrenholzia tribulosa* Ferris. Type from *Perognathus californicus* (California, U. S. A.). Also from *Perognathus formosus* (California).

1916. *Fahrenholzia tribulosa* Ferris, Psyche, Vol. 23 (in press).

Genus *Hæmodipsus* Enderlein

Hæmodipsus Enderlein, Zool. Anz., Vol. 28, pp. 139, 143 (1904); Dalla Torre, Gen. Ins., Anopl., p. 15 (1908); Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 165 (1910); Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 27-28 (1915).

Hæmatopinus (Polyplax) Neumann, Arch. de Par., Vol. 13, p. 536 (1909).

Anterior legs small with slender claw, middle and posterior legs larger, sub-equal, with heavier claws. Head broad, thorax very small. Abdomen entirely without chitinized tergites and sternites, each segment with a single transverse row of spines or hairs. Pleural plates very small or wanting. Gonapods very short.

Recorded only from *Leporidæ* (Rodentia).

Type of the genus *Hæmodipsus lyriocephalus* (Burm.).

1—*Hæmodipsus lyriocephalus* (Burm.). Type from *Lepus timidus* (Europe). Also from *L. europæus occidentalis* (Europe).

1839. *Pediculus lyriocephalus* Burmeister, Gen. Rhyn. No. 11, f. 7.

1842. *Hæmatopinus lyriocephalus* Denny, Mon. Anopl., pp. 27-28; pl. 24, f. 4.

1864. *Pediculus lyriceps* Nitzsch, Zeits. f. ges. Naturw., Vol. 23, p. 24.

1874. *Hæmatopinus lyriocephalus* Giebel, Ins. Epizoa, pp. 39-40; pl. 2, f. 2.

1880. *Hæmatopinus lyriocephalus* Piaget, Les Ped., pp. 641-642; pl. 52, f. 5.

1904. *Hæmodipsus lyriocephalus* Enderlein, Zool. Anz., Vol. 28, p. 143.

1908. *Hæmodipsus lyriocephalus* Dalla Torre, Gen. Ins., Anopl., p. 15.

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1909. *Hæmatopinus (Polyplax) lyriocephalus* Neumann, Arch. de Par., Vol. 13, p. 528.
1910. *Hæmodipsus lyriocephalus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 165.
1913. *Hæmodipsus lyriocephalus* Evans, Proc. Royal Phys. Soc. Edinburgh, Vol. 19, p. 94.
1915. *Hæmodipsus lyriocephalus* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 28.

2—*Hæmodipsus ventricosus* (Denny). From *Oryctolagus cuniculus* (Europe). Also from "domestic rabbit" (Europe and North America), *Lepus campestris* (Iowa, U. S. A.), *Lepus californicus* (California, U. S. A.), and *L. californicus deserticola* (Arizona, U. S. A.).

1842. *Hæmatopinus ventricosus* Denny, Mon. Anopl., pp. 30-31; pl. 25, f. 6.
1874. *Hæmatopinus ventricosus* Giebel, Ins. Epizoa, p. 47.
1880. *Hæmatopinus ventricosus* Piaget, Les Ped., p. 642.
1885. *Hæmatopinus ventricosus* Piaget, Les Ped., Suppl., pp. 141-147; pl. 16, f. 9.
1896. *Hæmatopinus ventricosus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 182.
1904. *Hæmodipsus ventricosus* Enderlein, Zool. Anz., Vol. 28, p. 143.
1908. *Hæmodipsus ventricosus* Dalla Torre, Gen. Ins., Anopl., p. 15.
1909. *Hæmatopinus (Polyplax) ventricosus* Neumann, Arch. de Par., Vol. 13, pp. 527-528, f. 27.
1910. *Hæmodipsus ventricosus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 165.
1913. *Polyplax ventricosa* Evans, Proc. Royal Phys. Soc. Edinburgh, Vol. 19, p. 94.
1915. *Hæmodipsus ventricosus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 28-30; t. f. 11; pl. 2, f. 2; pl. 4, f. 5; pl. 5, f. 12.
1916. *Hæmodipsus ventricosus* Ferris, Psyche, Vol. 23 (in press).

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Genus *Hoplopleura* Enderlein

Hoplopleura Enderlein, Zool. Anz., Vol. 28, pp. 221-223 (1904); Dalla Torre, Gen. Ins., Anopl., p. 14 (1908); Fahrenholz, 2-3-4th Jahresb. Niedersäch. Zool. Ver., pp. 44-46 (1912); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 15-16 (1915).

Hæmatopinus (Polyplax) Neumann, Arch. de Par., Vol. 13, p. 531 (1909).

Antennæ similar in the sexes. Anterior legs small with slender claw; middle legs larger with stouter claw; posterior legs very stout with stout, heavy claw and usually with a small, pointed protuberance on the anterior margin of the tibia. Female with most of the abdominal tergites divided into three transverse plates, each bearing a row of spines. Males with most of the abdominal tergites and sternites divided into two plates or undivided, but with some divided into three. Anterior division of the third sternite in both sexes with two pairs, or with two groups of three very stout and conspicuous spines. Pleural plates present.

From *Muridæ* and *Sciuridæ* (Rodentia).

Type of the genus *Hoplopleura acanthopus* (Burm.).

1—*Hoplopleura acanthopus* (Burm.). Type from *Microtus arvalis* (Europe). Also from *Microtus agrestis, Mus musculus* and (?) *Sorex araneus* (Europe) and *Dicrostonyx torquatus* (Pitlekaj).

1839. *Pediculus acanthopus* Burmeister, Gen. Rhyn., No. 5, pl. 1, f. 2.

1842. *Hæmatopinus acanthopus* Denny, Mon. Anopl., p. 25; pl. 24, f. 3.

1864. *Pediculus acanthopus* Nitzsch, Zeits. f. ges. Naturw., Vol. 23, p. 27.

1874. *Hæmatopinus acanthopus* Giebel, Ins. Ep., pp. 36-37; pl. 2, f. 3.

1880. *Hæmatopinus acanthopus* Piaget, Les Ped., pp. 638-640; pl. 52, f. 4.

1904. *Polyplax acanthopus* Enderlein, Zool. Anz., Vol. 28, p. 142.

1904. *Hoplopleura acanthopus* Enderlein, Ibid., Vol. 28, pp. 220-223, f. 1-2.

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1908. *Hoplopleura acanthopus* Dalla Torre, Gen. Ins., Anopl., p. 14.

1910. *Hoplopleura acanthopus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 164.

1912. *Hoplopleura acanthopus* Fahrenholz, 2-3-4th Jahresb. Niedersäch. Zool. Ver., pp. 46-52, f. 18-20; pl. 2, f. 14-15.

1a—*Hoplopleura acanthopus* var. *americanus* Kellogg & Ferris. Type from *Microtus californicus* (California, U. S. A.). Also from *M.* (*Lagurus*) *intermedius* and other species of *Microtus* (California, Iowa) and "white lemming" (Point Barrow, Alaska).

1891. *Hoplopleura acanthopus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 23, f. 11.

1896. *Hoplopleura acanthopus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 181-182, f. 104.

1915. *Hoplopleura acanthopus* var. *americanus* Kellogg and Ferris, Anopl. and Mall of N. Am. Mam., p. 16; t. f. 3; pl. 4, f. 2; pl. 5, f. 8.

2—*Hoplopleura arboricola* Kellogg & Ferris. Type from *Eutamias sonomæ* (California, U. S. A.). Also from *Sciurus griseus griseus, S. douglasi mollipilosus, S. douglasi albolimbatus, Eutamias alpinus, E. hindsi, E. sonomæ, E. merriami pricei, E. townsendi ochrogenys, E. speciosus frater* (California), and *Tamias striatus* (Iowa, U. S. A.).

1915. *Hoplopleura arboricola* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 19-21; t. f. 6-7; pl. 4, f. 4; pl. 6, f. 8.

1916. *Hoplopleura arboricola* Ferris, Psyche, Vol. 23 (in press).

3—*Hoplopleura bidentata* (Neumann). From *Epimys rattus* (Lake Torrens, Australia).

1909. *Hæmatopinus* (*Polyplax*) *bidentatus* Neumann, Arch. de Par., Vol. 13, pp. 515-517, f. 18.

1915. *Hoplopleura* ? *bidentata* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 155.

4—*Hoplopleura enormis* Kellogg & Ferris. From *Arvicanthis dorsalis* (S. Africa).

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1915. *Hoplopleura enormis* Kellogg & Ferris, Ann. Durban. Mus., Vol. 1, pt. 2, pp. 155-157; pl. 16, f. 4-4e.

5—*Hoplopleura erratica* (Osborn). Type from *Larus bonapartii* (straggler). Also from *Glaucomys volans, Microtus pennsylvanicus* and *Tamias striatus* (North America).

1896. *Hæmatopinus erraticus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 186.

1904. *Polyplax ? erraticus* Enderlein, Zool. Anz., Vol. 28, p. 143.

1908. *Polyplax ? erratica* Dalla Torre, Gen. Ins., Anopl., p. 13.

1915. *Hoplopleura ? erratica* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 18-19.

NOTE: One of the three species, *Hoplopleura arboricola* Kellogg & Ferris, *H. trispinosa* Kellogg & Ferris, or *H. acanthopus* var. *americanus* Kellogg & Ferris, is probably a synonym of this species.

6—*Hoplopleura hesperomydis* (Osborn). Type from *Peromyscus leucopus* (Iowa, U. S. A.). Also from *Peromyscus maniculatus rubidus, P. maniculatus gambeli, P. boylei* and *Mus musculus* (California, U. S. A.).

1891. *Hæmatopinus hesperomydis* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 26, f. 14.

1896. *Hæmatopinus hesperomydis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 184-185, f. 108.

1904. *Polyplax ? hesperomydis* Enderlein, Zool. Anz., Vol. 28, p. 143.

1908. *Polyplax ? hesperomydis* Dalla Torre, Gen., Anopl., p. 13.

1915. *Hoplopleura hesperomydis* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 17; t. f. 4-5; pl. 4, f. 1; pl. 5, f. 14.

7—*Hoplopleura hirsuta* Ferris. Type from *Sigmodon hispidus* (North Carolina, U. S. A.). Also from *Sigmodon hispidus texianus* (Texas, U. S. A.) and *S. hispidus eremicus* (California, U. S. A.).

1916. *Hoplopleura hirsuta* Ferris, Psyche, Vol. 23 (in press).

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8—*Hoplopleura hispida* (Grube). From *Lemmus obensis* (Siberia).

1851. *Pediculus hispidus* Grube, Midd. Reise, Zool., p. 497; pl. 32, f. 2 (figure labeled *P. gracilis*).
1874. *Hæmatopinus hispidus* Giebel, Ins. Ep., p. 38.
1880. *Hæmatopinus hispidus* Piaget, Les Ped., p. 640.
1904. *Polyplax hispida* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax hispida* Dalla Torre, Gen. Ins., Anopl., p. 13.

Note: This is probably a synonym of *H. acanthopus* (Burm.).

9—*Hoplopleura intermedia* Kellogg & Ferris. Type from *Mus coucha* (Zululand, South Africa).

1915. *Hoplopleura intermedia* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, pp. 153-154; pl. 16, f. 5-5d.
1916. *Hoplopleura intermedia* Ferris, ibid., Vol. 23 (in press).

10—*Hoplopleura longula* (Neumann). From *Micromys minutus* (Europe).

1909. *Hæmatopinus* (*Polyplax*) *longulus* Neumann, Arch. de Par., Vol. 13, pp. 513-515, f. 15-17.
1910. *Hoplopleura lineata* Fahrenholz, Zool. Anz., Vol. 35, p. 715, fig.
1915. *Hoplopleura* ? *longula* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 155.

11—*Hoplopleura maniculata* (Neumann). From *Sciurus palmarum* (Asia).

1909. *Hæmatopinus (Polyplax) maniculatus* Neumann, Arch. de Par., Vol. 13, pp. 521-523, f. 21-22.
1915. *Hoplopleura* ? *maniculata* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 155.

12—*Hoplopleura quadridentata* (Neumann). Type from *Holochilus squamipes* (probably *Ncctomys squamipes* or *Nectomys apicalis*) (Peru, South America). Also from *Nesoryzomys indefessus* and *N. narboroughi* (Galapagos Islands, South America).

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1909. *Hæmatopinus* (*Polyplax*) *quadridentatus* Neumann, Arch. de Par., Vol. 13, pp. 513-515.
1915. *Hoplopleura* ? *quadridentata* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 155.
1916. *Hoplopleura quadridentata* Ferris, Psyche, Vol. 23 (in press).

13—*Hoplopleura trispinosa* Kellogg & Ferris. Type from *Glaucomys sabrinus* ssp. ? (Oregon, U. S. A.). Also from *Glaucomys sabrinus lascivus* (California, U. S. A.) and *G. volans* (Maryland, U. S. A.).

1915. *Hoplopleura trispinosa* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 22-23, t. f. 8; pl. 4, f. 3.
1916. *Hoplopleura trispinosa* Ferris, Psyche, Vol. 23 (in press).

Genus *Hybophthirus* Enderlein

Enderlein, Denksch. d. Med.-Naturw. Gesell. zu Jena, Vol. 14, p. 79 (1909); Cummings, Bul. Ent. Res., Vol. 4, p. 44 (1913).

Tarsus of anterior legs two-segmented, of the remainder one-segmented. Anterior legs small and slender, middle and posterior legs large and stout. Abdomen without strongly chitinized tergites and sternites. Pleural plates present. Thorax with a flattened triangular process on the dorsum near each lateral margin.

Recorded only from Orycteropodidæ (Tubulidentata).

Type of the genus *Hybophthirus notophallus* (Neumann).

1—*Hybophthirus notophallus* (Neumann). From *Orcyteropus afer* (South Africa, German East Africa).

1909. *Hæmatopinus notophallus* Neumann, Jahrb. des Nassausichen Ver. f. Naturkunde, in Wiesbaden, p. 2.
1909. *Hybophthirus orycteropodi* Enderlein, Denksch. des Med.-Naturw. Gesell. zu Jena, Vol. 14, pp. 79-80; pl. 8, f. 1-3.
1913. *Hybophthirus notophallus* Cummings, Bul. Ent. Res., Vol. 4, pp. 44-45.
1914. *Hybophthirus notophallus* Waterston, Ann. S. Af. Mus., Vol. 10, pt. 9, p. 278.

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Genus *Linognathoides* Cummings

Cummings, Bul. Ent. Res., Vol. 5, pp. 159-160 (1914); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 23-24 (1915).

In general similar to *Polyplax*. Abdomen without chitinized tergal and sternal plates or with these very much reduced. Pleural plates present. Spiracles small.

Recorded from Muridæ and Sciuridæ (Rodentia).

Type of the genus *Linognathoides citelli* Cummings.

1—*Linognathoides citelli* Cummings. From *Citellus leptodactylus* and ? *Cricetulus phœus* (Transcaspia).

1914. *Linognathoides spermophili* Cummings, Bul. Ent. Res., Vol. 5, pp. 160-163, t. f. 3.

1916. *Linognathoides citelli* Cummings, Ann. Mag. Nat. Hist., ser. 8, Vol. 17, p. 107.

2—*Linognathoides inornatus* Kellogg & Ferris. Type from *Neotoma cinerea occidentalis* (California, U. S. A.). Also from *N. cinerea cinerea* and ? *N. fuscipes streatori* (California).

1915. *Linognathoides inornatus* Kellogg & Ferris, Anopl. & Mall. of Am. Mam., pp. 25-27, t. f. 10; pl. 2, f. 1; pl. 4, f. 7; pl. 5, f. 15; pl. 6, f. 3.

1916. *Linognathoides inornatus* Ferris, Psyche, Vol. 23 (in press).

3—*Linognathoides lævius culus* (Grube). Type from *Citellus eversmanni* (Jakutsk, Siberia).

1851. *Pediculus lævius culus* Grube, Middendorff's Reise, Vol. 2, p. 498; pl. 32, f. 5 (figure labeled P. spermophili).

1874. *Hæmatopinus lævius culus* Giebel, Ins. Epizoa, p. 38.

1880. *Hæmatopinus lævius culus* Piaget, Les Ped., p. 641.

1904. *Polyplax lævius culus* Enderlein, Zool. Anz., Vol. 28, p. 142.

1908. *Polyplax lævius culus* Dalla Torre, Gen. Ins., Anopl., p. 13.

1910. *Polyplax lævius cula* Mjöberg, Ark. f. Zool., Vol. 6. pt. 13, p. 160.

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4—*Linognathoides montanus* (Osborn). Type from "Western Gray Squirrel" (probably *Citellus* sp.) (Ft. Collins, Colorado, U. S. A.). Also from *Citellus barrowensis* ? (Pt. Barrow, Alaska), *Citellus beecheyi*, *C. douglasi* (California, U. S. A., *C. columbianus* (Washington, U. S. A.), *C. grammurus* (Arizona, U. S. A.), *C. mexicanus* ? (Guanajuato, Mexico), *Marmota flaviventris sierræ* (California, U. S. A.) and "Rock Squirrel" (Boulder, Colorado, U. S. A.).

1896. *Hæmatopinus montanus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 184, f. 107.
1900. *Hæmatopinus columbianus* Osborn, Can. Ent., Vol. 32, pp. 215-216.
1904. *Polyplax ? montana* Enderlein, Zool. Anz., Vol. 28, p. 143.
1904. *Polyplax ? columbiana* Enderlein, Ibid., p. 143.
1908. *Polyplax ? columbiana* Dalla Torre, Gen. Ins., Anopl., p. 13.
1908. *Polyplax ? montana* Dalla Torre, Ibid., p. 13.
1914. *Linognathoides ? columbianus* Cummings, Bul. Ent. Res., Vol. 5, p. 160.
1915. *Linognathoides montanus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 24-25; t. f. 9; pl. 5, f. 1; pl. 6, f. 4.
1916. *Linognathoides montanus* Ferris, Psyche, Vol. 23 (in press).

5—*Linognathoides pectinifer* (Neumann). From *Xerus getulus* (Northern Africa).

1885. *Hæmatopinus setosus* (not of Burmeister) Piaget, Les Ped., Suppl., p. 143; pl. 15, f. 6.
1908. *Hæmatopinus setosus* Dalla Torre, Gen. Ins., Anopl., p. 11.
1909. *Hæmatopinus (Polyplax) pectinifer* Neumann, Arch. de Par., Vol. 13, pp. 528-529, f. 28-29.
1914. *Linognathoides setosus* Cummings, Bul. Ent. Res., Vol. 5, p. 160.

Genus *Linognathus* Enderlein

Trichaulus Enderlein, Zool. Anz., Vol. 28, pp. 139, 141 (1904).

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Linognathus Enderlein, Ibid., Vol. 29, p. 194 (1905); Dalla Torre, Gen. Ins., Anopl., p. 12 (1908); Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 156 (1910); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 10 (1915).

Solenopotes Enderlein, Zool. Anz., Vol. 28, p. 143 (1904); Dalla Torre, Gen. Ins., Anopl., p. 15 (1908).

Hæmatopinus (Linognathus) Neumann, Arch. de Par., Vol. 13, pp. 529-530 (1909).

Head usually rather slender and elongated. Temporal angles not prominent. Middle and posterior legs nearly equal in size, larger and stouter than the anterior. Abdomen entirely without chitinized tergal, sternal and pleural plates. Each abdominal segment with two or three transverse rows of hairs. Spiracles large. Gonapods usually long.

From *Perissodactyla, Artiodactyla, Hyracoidea,* and from the domestic dog.

Type of the genus *Linognathus piliferus* (Burm.).

1—*Linognathus angulatus* (Piaget). Type from *Cephalophus nigrifrons* (Africa). Also from *Cephalophus natalensis* and *Cephalophus* sp. (Africa).

1885. *Hæmatopinus ungulatus* Piaget, Les Ped., Suppl., p. 144; pl. 15, f. 7.

NOTE: *ungulatus* is evidently a misprint for *angulatus,* the latter appearing in the description of the plates.

1908. *Hæmatopinus ungulatus* Dalla Torre, Gen. Ins., Anopl., p. 11.

1910. *Linognathus angulatus* Mjöberg, Ark. f. Zool., p. 157.

1916. *Linognathus angulatus* Ferris, Ann. Durban Mus., Vol. 2 (in press).

2—*Linognathus breviceps* (Piaget). Type from *Cephalophus maxwelli* (Africa). Also from ? "Cearrus-Hirsch" (Guatemala).

1885. *Hæmatopinus breviceps* Piaget, Les Ped., Suppl., p. 142; pl. 15, f. 5.

1908. *Hæmatopinus breviceps* Dalla Torre, Gen. Ins., Anopl., p. 11.

NOTE: This species is probably the young of *Linognathus angulatus* (Piaget).

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3—*Linognathus brevicornis* (Giebel). From *Giraffa camelopardalis* (Africa).

1874. *Hæmatopinus brevicornis* Giebel, Ins. Epizoa, pp. 43-44.

1880. *Hæmatopinus brevicornis* Piaget, Les Ped., pp. 644-646; pl. 52, f. 7.

1904. *Trichaulus brevicornis* Enderlein, Zool. Anz., Vol. 28, p. 142.

1905. *Linognathus brevicornis* Enderlein, Ibid., Vol. 29, p. 194.

1908. *Linognathus brevicornis* Dalla Torre, Gen. Ins., Anopl., p. 12.

4—*Linognathus caviæ-capensis* (Pallas). From *Procavia capensis* (South Africa).

1767. *Pediculus caviæ-capensis* Pallas, Spicilegia Zoologica, Vol. 12, p. 32; pl. 3, f. 12-13.

1874. *Hæmatopinus leptocephalus* Giebel, Ins. Epizoa, p. 47.

1880. *Hæmatopinus leptocephalus* Piaget, Les Ped., p. 656.

1904. *Hæmatopinus leptocephalus* Enderlein, Zool. Anz., Vol. 28, p. 141.

1908. *Hæmatopinus leptocephalus* Dalla Torre, Gen. Ins., Anopl., p. 11.

1913. *Linognathus caviæ-capensis* Cummings, Bul. Ent. Res., Vol. 4, pp. 37-39, f. 2-3.

5—*Linognathus fahrenholzi* Paine. Type from *Cervicapra arundinum* (Nyasaland, Africa). Also from *Cervicapra fulvorufula* (Zululand, Africa).

1911. *Linognathus forficulus* (not of Rudow) Kellogg & Paine, Bul. Ent. Res., Vol. 2, p. 147; pl. 4, f. 2-4.

1914. *Linognathus fahrenholzi* Paine, Psyche, Vol. 21, p. 117.

1916. *Linognathus fahrenholzi* Ferris, Ann. Durban Mus., Vol. 2 (in press).

6—*Linognathus forficulus* (Rudow). From *Capra ibex* (Europe).

1869. *Hæmatopinus forficulus* Rudow, Zeit. f. ges. Naturw., Vol. 34, p. 169.

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1874. *Hæmatopinus forficulus* Giebel, Ins. Epizoa, p. 47.
1908. *Hæmatopinus? forficulus* Dalla Torre, Gen. Ins., Anopl., p. 11.
1914. *Linognathus forficulus* Paine, Psyche, Vol. 21, p. 117.

7—*Linognathus gazella* Mjöberg. From "gazelle." (Zool. Mus. Hamburg).
1910. *Linognathus gazella* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 157-159, f. 78.

8—*Linognathus leptocephalus* (Ehrenberg). From *Procavia syriacus* (Syria).
1829. *Pediculus leptocephalus* Ehrenberg, Symbolæ Physicæ.
1874. *Hæmatopinus leptocephalus* Giebel, Ins. Epizoa, p. 47.
1880. *Hæmatopinus leptocephalus* Piaget, Les Ped., p. 656.
1904. *Hæmatopinus leptocephalus* Enderlein, Zool. Anz., Vol. 28, p. 141.
1908. *Hæmatopinus leptocephalus* Dalla Torre, Gen. Ins., Anopl., p. 11.
1913. *Linognathus leptocephalus* Cummings, Bul. Ent. Res., Vol. 4, p. 37.

9—*Linognathus limnotragi* Cummings. From *Limnotragus gratus* (Congo, Africa).
1913. *Linognathus limnotragi* Cummings, Bul. Ent. Res., Vol. 4, pp. 36-37, f. 1.

10—*Linognathus ovillus* (Neumann). From domestic sheep (Scotland and New Zealand).
1907. *Hæmatopinus ovillus* Neumann, Revue veterinaire, pp. 520-524.
1913. *Linognathus ovillus* Evans, Proc. Royal Phys. Soc. Edinburgh, Vol. 19, p. 94.

11—*Linognathus pedalis* (Osborn). From domestic sheep (Minnesota, Iowa and Nevada, U. S. A.).
1896. *Hæmatopinus pedalis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 170-172, f. 99.

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1896. *Hæmatopinus ovis* Lugger, Rept. Ent., State Exper. Station, Minnesota, pp. 105-106, f. 75-76.
1904. *Trichaulus pedalis* Enderlein, Zool. Anz., Vol. 28, p. 142.
1905. *Linognathus pedalis* Enderlein, Zool. Anz., Vol. 29, p. 194.
1908. *Linognathus pedalis* Dalla Torre, Gen. Ins., Anopl., p. 12.
1915. *Linognathus pedalis* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 11.

12—*Linognathus piliferus* (Burmeister). From domestic dog (Cosmopolitan). Also once recorded from a ferret (England).

1776. *?Pediculus canis familiaris* Müller, Prodr. Faunæ Daniæ, p. 184.
1780. *?Pediculus canis familiaris* Fabricius, Fauna Gröenland, p. 215.
1838. *Pediculus piliferus* Burmeister, Gen. Rhyn., No. 13.
1842. *Hæmatopinus piliferus* Denny, Mon. Anopl., pp. 28-29; pl. 25, f. 4.
1847. *Hæmatopinus bicolor* Lucas, Ann. Soc. Ent. France, Vol. 5, ser. 2, pp. 538-539; pl. 8, f. 2a.
1861. *Pediculus isopus* Nitzsch, Zeit. f. ges. Naturw., Vol. 18, p. 290.
1864. *Pediculus flavidus* Nitzsch, Ibid., Vol. 23, p. 27.
1874. *Hæmatopinus piliferus* Giebel, Ins. Epizoa, pp. 40-41.
1880. *Hæmatopinus piliferus* Piaget, Les Ped., pp. 643-644; pl. 52, f. 6.
1891. *Hæmatopinus piliferus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 11-12, f. 5.
1896. *Hæmatopinus piliferus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 169, f. 98.
1904. *Trichaulus piliferus* Enderlein, Zool. Anz., Vol. 28, p. 142.
1905. *Linognathus piliferus* Enderlein, Ibid., Vol. 29, p. 194.

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1908. *Linognathus piliferus* Dalla Torre, Gen. Ins., Anopl., p. 12.

1910. *Linognathus piliferus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 157, f. 77.

1915. *Linognathus piliferus* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 11.

13—*Linognathus prælongiceps* (Neumann). From *Auchenia huanaca* (Bolivia, S. America).

1909. *Hæmatopinus (Linognathus) prælongiceps* Neumann, Arch. de Par., Vol. 13, pp. 508-511, f. 10-12.

14—*Linognathus stenopsis* (Burmeister). Type from domestic goat (Europe). Also from domestic goat (California, U. S. A.), sheep (Africa), *Antilope rupicapra* and *Capra ægyptica.*

1838. *Pediculus stenopsis* Burmeister, Gen. Rhyn., No. 3.

1842. *Hæmatopinus stenopsis* Denny, Mon. Anopl., p. 36.

1847. *Pediculus saccatus* Gervais, Apteres, Vol. 3, p. 307.

1864. *Pediculus stenopsis* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 30.

1864. *Pediculus schistopygus* Nitzsch, Ibid., Vol. 23, p. 31.

1874. *Hæmatopinus saccatus* Giebel, Ins. Epizoa, p. 47.

1874. *Hæmatopinus stenopsis* Giebel, Ibid., p. 44; pl. 2., f. 4.

1880. *Hæmatopinus saccatus* Piaget, Les Ped., p. 648.

1880. *Hæmatopinus stenopsis* Piaget, Ibid., p. 648.

1891. *Hæmatopinus stenopsis* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 12.

1896. *Hæmatopinus stenopsis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 170.

1904. *Trichaulus saccatus* Enderlein, Zool. Anz., Vol. 28, p. 142.

1904. *Trichaulus stenopsis* Enderlein, Ibid., Vol. 28, p. 142.

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1905. *Linognathus saccatus* Enderlein, Ibid., Vol. 29, p. 194.
1905. *Linognathus stenopsis* Ibid., Vol. 29, p. 194.
1908. *Linognathus saccatus* Dalla Torre, Gen. Ins., Anopl., p. 12.
1908. *Linognathus stenopsis* Dalla Torre, Ibid., p. 12.
1910. *Linognathus stenopsis* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 159.
1911. *Linognathus africanus* Kellogg & Paine, Bul. Ent. Res., Vol. 2, p. 146; pl. 4, f. 1, 5.
1915. *Linognathus stenopsis* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 11.

NOTE: *Linognathus saccatus* is an unrecognizable species, recorded from *Capra ægyptica* (equals *Capra ægagrus* ?), but it is very probably the same as *Linognathus stenopsis.*

15—*Linognathus rupicapræ* (Rudow). From *Rupicapra rupicapra* (Europe).
1869. *Hæmatopinus rupicapræ* Rudow, Zeit. f. ges. Naturw., Vol. 34, p. 170.
1874. *Hæmatopinus rupicapræ* Giebel, Ins. Epizoa, p. 47.
1880. *Hæmatopinus rupicapræ* Piaget, Les Ped., p. 648.
1908. *Hæmatopinus rupicapræ* Dalla Torre, Gen. Ins., Anopl., p. 11.

16—*Linognathus tibialis* (Piaget). From *Antilope maori* (Zool. Garden, Rotterdam).
1880. *Hæmatopinus tibialis* Piaget, Les Ped., pp. 646-647; pl. 52, f. 8.
1904. *Trichaulus tibialis* Enderlein, Zool. Anz., Vol. 28, p. 142.
1905. *Linognathus tibialis* Enderlein, Ibid., Vol. 29, p. 194.
1908. *Linognathus tibialis* Dalla Torre, Gen. Ins., Anopl., p. 12.

16a—*Linognathus tibialis* var. *antennatus* (Piaget). From *Antilope* sp. (Zool. Garden, Rotterdam).
1880. *Hæmatopinus tibialis* var. *antennatus* Piaget, Les Ped., p. 647; pl. 52, f. 8e.

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1908. *Linognathus tibialis* var. *antennatus* Dalla Torre, Gen. Ins., Anopl., p. 12.

16b—*Linognathus tibialis* var. *appendiculatus* (Piaget). From *Antilope subgutturosa (=Gazella subgutturosa?)* (Zool. Garden, Rotterdam).

1880. *Hæmatopinus tibialis* var. *appendiculatus* Piaget, Les Ped., p. 647; pl. 52, f. 8g.

1908. *Linognathus tibialis* var. *appendiculatus* Dalla Torre, Gen. Ins., Anopl., p. 12.

16c—*Linognathus tibialis* var. *cervicapræ* (Lucas). From *Antilope cervicapra* (India).

1847. *Hæmatopinus cervicapræ* Lucas, Ann. Ent. Soc. France, Vol. 5, ser. 2, p. 534; pl. 7, f. 1.

1880. *Hæmatopinus tibialis* var. *cervicapræ* Piaget, Les Ped., p. 647.

1908. *Linognathus tibialis* var. *cervicapræ* Dalla Torre, Gen. Ins., Anopl., p. 13.

16d—*Linognathus tibialis* var. *euchore* Waterston. From *Antilope euchore* (Africa).

1914. *Linognathus tibialis* var. *euchore* Waterston, Ann. S. African Mus., Vol. 10, pt. 9, pp. 275-278, f. 1.

17—*Linognathus vituli* (Linnæus). From domestic cattle. (Cosmopolitan).

1758. *Pediculus vituli* Linnæus, Systema Naturæ, ed. 10, p. 611.

1766. *Pediculus vituli* Linnæus, Systema Naturæ, ed. 12, p. 1018.

1829. *Hæmatopinus vituli* Stephens, Catalogue, Vol. 2, p. 329.

1838. *Pediculus tenuirostris* Burmeister, Gen. Rhyn., No. 17.

1842. *Hæmatopinus vituli* Denny, Mon. Anopl., pp. 31-32; pl. 25, f. 3.

1864. *Pcdiculus oxyrrynchus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 21.

1874. *Hæmatopinus tenuirostris* Giebel, Ins. Epizoa, p. 43; pl. 2, f. 9.

1880. *Hæmatopinus tenuirostris* Piaget, Les Ped., p. 650.

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1883. *Hæmatopinus tenuirostris Stroebelt,* Ann. Mag. Nat. Hist., Vol. 11, ser. 5, pp. 73-108; pl. 3.
1885. *Hæmatopinus tenuirostris* Piaget, Les Ped., Suppl., pp. 145-146; pl. 15, f. 8.
1891. *Hæmatopinus vituli* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 16-18, f. 7.
1896. *Hæmatopinus vituli* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 176-177, f. 101.
1904. *Trichaulus vituli* Enderlein, Zool. Anz., Vol. 28, p. 142.
1904. *Solenopotes capillatus* Enderlein, Zool. Anz., Vol. 28, p. 144, f. 14,15.
1908. *Linognathus vituli* Dalla Torre, Gen. Ins., Anopl., p. 12.
1908. *Solenopotes capillatus* Dalla Torre, Ibid., p. 15.
1915. *Linognathus vituli* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 10.
1916. *Linognathus vituli* Ferris, Ent. News, Vol. 27 (in press).

Genus *Cervophthirius* Mjöberg

Cervophthirius Mjöberg, Ent. Tidskrift, Vol. 36, p. 282 (1915); Ferris, Ent. News, Vol. 27 (in press), 1916.

Differing from *Linognathus* only in the sharp posterior lateral angles of the head and the presence of but a single row of hairs upon each abdominal segment.

Recorded only from Cervidæ (Artiodactyla).

Type of the genus *Cervophthirius tarandi* Mjöberg.

1—*Cervophthirius crassicornis* (Nitzsch). Type from *Cervus elaphus* (Europe). Also from *Odocoileus columbianus* (California, U. S. A.).

1818. *Pediculus crassicornis* Nitzsch, Germar's Mag., Vol. 3, p. 305.
1842. *Hæmatopinus crassicornis* Denny, Mon. Anopl., p. 36.
1864. *Pediculus crassicornis* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 26.
1874. *Hæmatopinus crassicornis* Giebel, Ins. Epizoa, p. 41; pl. 2, f. 7.

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1880. *Hæmatopinus crassicornis* Piaget, Les Ped., p. 644.

1908. *Hæmatopinus crassicornis* Dalla Torre, Gen. Ins., Anopl., p. 11.

1916. *Cervophthirius crassicornis* Ferris, Ent. News, Vol. 27 (in press).

2—*Cervophthirius tarandi* Mjöberg. From *Rangifer tarandus* (Karesuando, Sweden).

1915. *Cervophthirius tarandi* Mjöberg, Ent. Tidskrift, Vol. 36, pp. 283-285, f. 1-4.

Note: It is extremely doubtful if this is at all distinct from *Cervophthirius crassicornis* (N.).

Genus *Eulinognathus* Cummings

Eulinognathus Cummings, Ann. Mag. Nat. Hist., ser. 8, Vol. 17, p. 90 (1916).

Head longer than broad, antennæ arising just in front of half way, broader behind the antennæ than in front. Behind, the head is sunk deep into the thorax. Around the mouth, in front, a circlet of triangular denticles. Abdomen without tergites or sternites. Five pairs of pleurites, the anterior pair well developed. First pair of legs small, second and third larger, sub-equal. Hairs on the abdomen modified, long, flattened, parallel-sided, truncate at tip, one row on each segment.

Type of the genus *Eulinognathus denticulatus* Cummings.

Recorded from *Pedetidæ* and *Dipodidæ* (Rodentia).

1—*Eulinognathus denticulatus* Cummings. From *Pedetes caffer.*

1916. *Eulinognathus denticulatus* Cummings, Ann. Mag. Nat. Hist., ser. 8, Vol. 17, pp. 90-94, f. 1.

2—*Eulinognathus aculeatus* (Neumann). From *Dipus* sp. (Djerba, Tunis).

1912. *Hæmatopinus (Polyplax) aculeatus* Neumann, Bul. Soc. Zool., France, Vol. 37, pp. 143-145, f. 5-6.

Genus *Neohæmatopinus* Mjöberg

Neohæmatopinus Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 160 (1910); Cummings, Bul. Ent. Res., Vol. 3, p. 393

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(1912); Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 35-36.

Acanthopinus Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 160-161 (1910).

Antennæ dissimilar in the sexes, the male with a preaxial process or a pair of spines at the apex of the third antennal segment. First antennal segment in both sexes usually with the distal post axial angle more or less produced and bearing a stout spine or with a stout spine on the posterior margin. Anterior legs small, with slender claw, middle and posterior legs larger. Abdomen with or without chitinized tergal and sternal plates. Abdominal tergites and sternites of the female, for the most part, with two transverse rows of spines, male with lesser number, bearing two rows of spines. Posterior margin of second tergite of male always distinctly emarginate with a closely set group of spines of various lengths at the end of this emargination. Pleural plates present. Spiracles small. Gonapods very short.

Recorded from *Sciuridæ* and *Petauristidæ* (Rodentia).

Type of the genus *Neohæmatopinus sciuropteri* (Osborn).

1—*Neohæmatopinus antennatus* (Osborn). Type from *Sciurus cinereus* var. *ludovicianus* (probably *S. niger rufiventer*), (Iowa, U. S. A.). Also from *Sciurus griseus griseus* (California, U. S. A.).

1891. *Hæmatopinus antennatus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 25, f. 13.

1896. *Hæmatopinus antennatus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 183-184, f. 106.

1904. *Polyplax ? antennata* Enderlein, Zool. Anz., Vol. 28, p. 143.

1908. *Polyplax ? antennata* Dalla Torre, Gen. Ins., Anopl., p. 13.

1910. *Acanthopinus antennatus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 161.

1915. *Neohæmatopinus antennatus* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 36-37; t. f. 14a-14b; pl. 5, f. 10; pl. 6, f. 5.

1a—*Neohæmatopinus antennatus* var. *semifasciatus* Ferris. Type from *Sciurus douglasi albolimbatus* (California, U. S. A.). Also from *S. douglasi mollipilosus* (California).

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1915. *Neohæmatopinus antennatus* (in part) Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 36-37.

1916. *Neohæmatopinus antennatus* var. *semifasciatus* Ferris, Psyche, Vol. 23 (in press).

NOTE: This is perhaps identical with *Neohæmatopinus sciurinus* (Mjöb.).

2—*Neohæmatopinus echinatus* (Neumann). From *Sciurus palmarum* (Asia). Also as straggler or mistaken record from a bat, *Scotophilus wroughtoni* (Asia).

1909. *Hæmatopinus (Polyplax) echinatus* Neumann, Arch. de Par., Vol. 13, pp. 517-521, f. 19-20.

1912. *Neohæmatopinus echinatus* Cummings, Bul. Ent. Res., Vol. 3, p. 393.

3—*Neohæmatopinus heliosciuri* Cummings. From *Heliosciurus palliatus* (British East Africa).

1912. *Neohæmatopinus helioscuri* Cummings, Bul. Ent. Res., Vol. 3, pp. 393-395, f. 1.

4—*Neohæmatopinus pacificus* Kellogg & Ferris. Type from *Eutamias sonomæ* (California, U. S. A.). Also from *Eutamias hindsi, E. alpinus* and other species of *Eutamias.* (California).

1915. *Neohæmatopinus pacificus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 38-40; t. f. 14c-14d; pl. 1, f. 2; pl. 5, f. 3, 7a-7b.

1916. *Neohæmatopinus pacificus* Ferris, Psyche, Vol. 23 (in press).

5—*Neohæmatopinus sciurinus* (Mjöberg). From *Sciurus vulpinus* (Zool. Mus. Hamburg). (This is perhaps *Sciurus niger* of North America).

1910. *Acanthopinus sciurinus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 161-164, f. 80-83.

1912. *Neohæmatopinus sciurinus* Cummings, Bul. Ent. Res., Vol. 3, p. 393.

6—*Neohæmatopinus sciuropteri* (Osborn). Type from *Glaucomys volans* (Iowa, U. S. A.). Also from *Glaucomys sabrinus lascivus* and *G. sabrinus ssp.* (California, U. S. A.).

1891. *Hæmatopinus sciuropteri* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 23-24, f. 12.

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1896. *Hæmatopinus sciuropteri* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 182-183, f. 105.
1904. *Polyplax ? sciuropteri* Enderlein, Zool. Anz., Vol. 28, p. 143.
1908. *Polyplax ? sciuropteri* Dalla Torre, Gen. Ins., Anopl., p. 14.
1910. *Neohæmatopinus sciuropteri* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 160, f. 79.
1912. *Neohæmatopinus sciuropteri* Cummings, Bul. Ent. Res., Vol. 3, p. 393.
1915. *Neohæmatopinus sciuropteri* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 36; pl. 1, f. 1; pl. 5, f. 2, 13.
1916. *Neohæmatopinus sciuropteri* Ferris, Psyche, Vol. 23 (in press).

Genus *Polyplax* Enderlein

Polyplax Enderlein, Zool. Anz., Vol. 28, pp. 139, 142, 223 (1904); Dalla Torre, Gen. Ins., Anopl., p. 13 (1908); Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 159 (1910); Fahrenholz, 2-3-4th Jahresb. Niedersäch. Zool. Ver., pp. 29-30 (1912); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 11 (1915).

Hæmatopinus (Polyplax) Neumann, Arch. de Par., Vol. 13, pp. 529-532 (1909).

Eremophthirius Glinkiewicsz, Sitz. d. Kaiserl. Ak. Wiss. Wien, Natur. Klasse, Vol. 116, pp. 381-383 (1907).

Antennæ sometimes differing in the sexes, the male frequently having the third segment with a distal, preaxial process. Anterior legs small with slender claw, middle legs larger with stouter claw, posterior legs somewhat larger and with heavier claw than the middle. Female with most of the abdominal tergites and sternites divided into two transverse plates, each bearing a row of spines or hairs. Male with a smaller number of tergites and sternites thus divided. Pleural plates present. Spiracles small.

One species recorded from *Soricidæ* (Insectivora), one from *Myoxidæ* (Rodentia), the remainder from *Muridæ* (Rodentia).

Type of the genus *Polyplax spinulosa* (Burm.)

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1—*Polyplax affinis* (Burmeister). From *Apodemus sylvaticus* (Europe). Also from *?Apodemus agrarius* (Europe).

1839. *Pediculus affinis* Burmeister, Gen. Rhyn., No. 10.
1842. *Hæmatopinus affinis* Denny, Mon. Anopl., p. 36.
1864. *Pediculus affinis* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 22.
1874. *Hæmatopinus affinis* Giebel, Ins. Epizoa, p. 39; pl. 1, f. 9.
1880. *Hæmatopinus acanthopus* var. *affinis* Piaget, Les Ped., p. 639.
1904. *Polyplax affinis* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax affinis* Dalla Torre, Gen. Ins., Anopl., p. 13.
1912. *Polyplax affinis* Fahrenholz, 2-3-4th Jahresb. Niedersäch. Zool. Ver., pp. 39-42, f. 13-15.

2—*Polyplax auricularis* Kellogg & Ferris. Type from *Peromyscus maniculatus rubidus* (California, U. S. A.). Also from *Peromyscus sitchensis prevostensis* (Forrester Is., Alaska), *P. maniculatus gambeli* and *Onychomys torridus pulcher* (California) and *O. leucogaster arcticeps* (Colorado, U. S. A.).

1915. *Polyplax auricularis* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 13-15, t. f. 2; pl. 1, f. 4; pl. 4, f. 8.
1916. *Polyplax auricularis* Ferris, Psyche, Vol. 23 (in press).

3—*Polyplax brachyrrhynchus* Cummings. From *Acomys caharinus* (Egypt).

1914. *Polyplax brachyrrhynchus* Cummings, Proc. Zool. Soc. London, pp. 246-251, t. f. 1-3, 13-14.

4—*Polyplax clavicornis* (Nitzsch). From *Meriones* sp. (Northern Africa).

1864. *Pediculus clavicornis* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 32.
1869. *Hæmatopinus clavicornis* Nitzsch & Giebel, Ibid., Vol. 28, p. 397.

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1874. *Hæmatopinus clavicornis* Giebel, Ins. Epizoa, pp. 37-38.
1880. *Hæmatopinus clavicornis* Piaget, Les Ped., p. 640.
1904. *Polyplax clavicornis* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax clavicornis* Dalla Torre, Gen. Ins., Anopl., p. 13.

4—*Polyplax cummingsi* Ferris. From *Dasymys incomtus* (Zululand, S. Africa).
1916. *Polyplax cummingsi* Ferris, Ann. Durban Mus., Vol. 2 (in press).

5—*Polyplax gracilis* Fahrenholz. Type from *Micromys minutus* (Europe). Also from *Mus chrysophilus* (Zululand, South Africa).
1910. *Polyplax gracilis* Fahrenholz, Zool. Anz., Vol. 35, p. 715.
1912. *Polyplax gracilis* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 42-44, f. 16-17; pl. 1, f. 10-11.
1916. *Polyplax gracilis* Ferris, Ann. Durban Mus., Vol. 2 (in press).

6—*Polyplax jonesi* Kellogg & Ferris. From *Saccostomus campestris* (Zululand, South Africa).
1915. *Polyplax jonesi* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, pp. 151-152; pl. 15, f. 3-3e.
1916. *Polyplax jonesi* Ferris, Ibid., Vol. 2 (in press).

7—*Polyplax ? miacantha* Speiser. From "einer kleinen Ratte mit sehr dicken, stachelartigen Haaren." (Salomona, Abyssinia).
1905. *Polyplax miacantha* Speiser, Centralbl. f. Bakter., Vol. 38, pt. 1 (Originale), pp. 318-319. (Figure does not belong to it.)
1908. *Polyplax miacantha* Dalla Torre, Gen. Ins., Anopl., p. 13.

8—*Polyplax otomydis* Cummings. Type from *Otomys irroratus tropicalis* (British East Africa). Also from *Otomys irroratus* and *O. brantsi luteolus* (South Africa).
1912. *Polyplax otomydis* Cummings, Bul. Ent. Res., Vol. 3, pp. 395-397, f. 2.

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1914. *Polyplax otomydis* Waterston, Ann. S. Af. Mus., Vol. 10, p. 275.

1915. *Polyplax otomydis* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 150.

1916. *Polyplax otomydis* Ferris, Ibid., Vol. 2 (in press).

9—*Polyplax oxyrrhynchus* Cummings. From *Acomys caharinus* (Egypt).

1915. *Polyplax oxyrrhynchus* Cummings, Proc. Zool. Soc. Lond., pp. 251-260, 262-265; t. f. 4-6, 8-9, 11-13.

10—*Polyplax pectinata* Cummings. From *Epimys aurifer* (Malay Peninsula).

1913. *Polyplax pectinata* Cummings, Bul. Ent. Res., Vol. 4, pp. 35-36.

11—*Polyplax* ? *pleurophæa* (Burmeister). From *Dryomys nitedula* (Europe).

1839. *Pediculus pleurophæus* Burmeister, Gen. Rhyn., No. 7.

1864. *Pediculus pleurophæus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 27.

1874. *Hæmatopinus leucophæus* Giebel, Ins. Epizoa, p. 37.

1880. *Hæmatopinus leucophæus* Piaget, Les Ped., p. 640.

1904. *Polyplax pleurophæa* Enderlein, Zool. Anz., Vol. 28, p. 142.

1908. *Polyplax pleurophæa* Dalla Torre, Gen. Ins., Anopl., p. 13.

12—*Polyplax reclinata* (Nitzsch). From *Sorex araneus* (Europe).

1864. *Pediculus reclinatus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 23.

1874. *Hæmatopinus reclinatus* Giebel, Ins. Epizoa, p. 37.

1880. *Hæmatopinus reclinatus* Piaget, Les Ped., p. 639.

1904. *Polyplax reclinata* Enderlein, Zool. Anz., Vol. 28, p. 142.

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1904. *Hoplopleura reclinata* Enderlein, Ibid., Vol. 28, p. 222.
1908. *Hoplopleura reclinata* Dalla Torre, Gen. Ins., Anopl., p. 14.
1910. *Hæmatopinus (Polyplax) spiniger reclinatus* Neumann,Arch. de Par., Vol. 13, pp. 524-525, f. 24.
1912. *Polyplax reclinata* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 37-39, f. 11-12; pl. 1, f. 12-13; pl. 2, f. 2-4; pl. 3, f. 7.

13—*Polyplax serrata* (Burmeister). From *Mus musculus* (Europe).
1839. *Pediculus serratus* Burmeister, Gen. Rhyn., No. 6.
1842. *Hæmatopinus serratus* Denny, Mon. Anopl., p. 36.
1864. *Pediculus serratus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 27.
1874. *Hæmatopinus serratus* Giebel, Ins. Epizoa, p. 36; pl. 1, f. 6.
1880. *Hæmatopinus serratus* Piaget, Les Ped., p. 639.
1904. *Polyplax serrata* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax serrata* Dalla Torre, Gen. Ins., Anopl., p. 14.
1913. *Polyplax serrata* Evans, Proc. Roy. Phys. Soc. Edinburgh, Vol. 19, p. 94.

14—*Polyplax ? spiculifera* (Gervais). From *Mus barbarus* (Algiers).
1844. *Pediculus spiculifer* Gervais, Aptères, Vol. 3, p. 302.
1874. *Hæmatopinus spiculifer* Giebel, Ins. Epizoa, p. 37.
1880. *Hæmatopinus spiculifer* Piaget, Les Ped., p. 639.
1904. *Polyplax spiculifera* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax spiculifera* Dalla Torre, Gen. Ins., Anopl., p. 14.

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15—*Polyplax spiniger* (Burmeister). From *Arvicola amphibius* (Europe).

1839. *Pediculus spiniger* Burmeister, Gen. Rhyn., No. 9, f. 5.
1842. *Hæmatopinus spiniger* Denny, Mon. Anopl., p. 27; pl. 24, f. 6.
1864. *Pediculus spiniger* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 23.
1874. *Hæmatopinus spiniger* Giebel, Ins. Epizoa, p. 39; pl. 2, f. 1.
1880. *Hæmatopinus spiniger* Piaget, Les Ped., pp. 637-638; pl. 52, f. 3.
1904. *Polyplax spinigera* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax spinigera* Dalla Torre, Gen. Ins., Anopl., p. 14.
1909. *Hæmatopinus (Polyplax) spiniger* Neumann, Arch. de Par., Vol. 13, p. 524, f. 24.

16—*Polyplax spinulosa* (Burmeister). Type from *Epimys norvegicus* (Europe). Also from *Epimys rattus* and *E. rattus alexandrinus* (Cosmopolitan) and *Microtus californicus* and *Phenacomys longicaudus* (California, U. S. A.).

1839. *Pediculus spinulosus* Burmeister, Gen. Rhyn., No. 8.
1842. *Hæmatopinus spinulosus* Denny, Mon. Anopl., p. 26; pl. 24, f. 5.
1864. *Pediculus denticulatus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 24.
1874. *Hæmatopinus spinulosus* Giebel, Ins. Epizoa, pp. 38-39; pl. 1, f. 7.
1880. *Hæmatopinus spinulosus* Piaget, Les Ped., pp. 636-637; pl. 52, f. 2.
1891. *Hæmatopinus spinulosus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 22.
1896. *Hæmatopinus spinulosus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 18.
1904. *Polyplax spinulosa* Enderlein, Zool. Anz., Vol. 28, p. 142.
1905. *Polyplax spinulosa* Enderlein, Ibid., Vol. 29, pp. 192-194.

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1908. *Polyplax spinulosa* Dalla Torre, Gen. Ins., Anopl., p. 14.
1909. *Hæmatopinus (Polyplax) spinulosus* Neumann, Arch. de Par., Vol. 13, p. 526, f. 26.
1910. *Polyplax spinulosa* Mjöberg, Ark. f. Zool., Vol. 6, No. 13, p. 160.
1912. *Polyplax spinulosa* Fahrenholz, 2-3-4th Jahresb. de Niedersäch. Zool. Ver., pp. 30-37, f. 8-10; pl. 2, f. 8-13.
1915. *Polyplax spinulosa* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 12-13; t. f. 1; pl. 5, f. 11a-11b; pl. 6, f. 7.

17—*Polyplax stephensi* (Christophers & Newstead). From *Gerbillus indicus* (India).
1906. *Hæmatopinus stephensi* Christophers & Newstead, Rept. Thompson Yates Lab., Liverpool, Vol. 7, p. 3; pl. 1.
1909. *Hæmatopinus (Polyplax) stephensi* Neumann, Arch. de Par., Vol. 13, pp. 525-526, f. 25.
1913. *Hæmatopinus (Polyplax) stephensi* Patton & Cragg, Med. Ent., pp. 550-551; pl. 68, f. 4-6.

18—*Polyplax villosa* Galli-Valerio. From *Microtus nivalis* (Europe).
1905. *Polyplax villosa* Galli-Valerio, Zool. Anz., Vol. 28, pp. 521-522.
1908. *Polyplax villosa* Dalla Torre, Gen Ins., Anopl., p. 14.
NOTE: Probably not a valid species.

19—*Polyplax werneri* (Glinkiewicz). From *Pachyuromys duprasi* (Egypt).
1907. *Eremophthirius werneri* Glinkiewicz, Sitzb. d. Kaiserl. Ak. d. Wissen. Wien. Math. Natur. Klasse, Vol. 116, pp. 381-383.
1910. *Hoplopleura ? werneri* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 164.

Genus *Scipio* Cummings

Cummings, Bul. Ent. Res., Vol. 3, p. 393 (1913); Ferris Ann. Durban Mus., Vol. 2 (in press).

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Antennæ not differing in the sexes. Middle and posterior legs subequal in size, large and with pointed claws. Anterior legs small and slender with slender claw and, arising close beside it, a curved, claw-like process. Abdomen large and soft, entirely without chitinized tergal and sternal plates except in the male, where these plates may be present as very narrow, transverse areas. Each segment with a single transverse row of spines. Pleurites present. Gonapods very short. Spiracles small. Male resembling female except for smaller size.

Recorded only from Octodontidæ (Rodentia).

Type of the genus, *Scipio aulacodi* (Neumann).

1—*Scipio aulacodi* (Neumann). Type from *Thryonomys swinderianus* (Africa). Also from *Thryonomys* sp. (Zululand, South Africa).

1911. *Hæmatopinus aulacodi* Neumann, Arch. de Par., Vol. 14, pp. 403-406, f. 5-7.

1913. *Scipio aulacodi* Cummings, Bul. Ent. Res., Vol. 3, p. 393.

1916. *Scipio aulacodi* Ferris, Ann. Durban Mus., Vol. 2 (in press).

2—*Scipio breviceps* Ferris. From *Thryonomys* sp. (Zululand, South Africa).

1916. *Scipio breviceps* Ferris, Ann. Durban Mus., Vol. 2 (in press).

Linognathinæ of Uncertain Position

1—*Hæmatopinus (Polyplax) præcisus* Neumann. From "gros Rats" (Abyssinia).

1901. *Hæmatopinus præcitus* (typographical error for præcisus) Neumann, Arch. de Par., Vol. 5, pp. 600-601.

1902. *Hæmatopinus præcisus* Neumann, Ibid., Vol. 6, p. 144, fig.

1908. *Polyplax* ? *præcisus* Dalla Torre, Gen. Ins., Anopl., p. 13.

1909. *Hæmatopinus (Polyplax) præcisus* Neumann, Arch. de Par., Vol. 13, pp. 523-524, f. 23.

Note: This seems to include the male of one species and the female of another; it is probable that they belong to different genera.

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2—*Hæmatopinus (Linognathus) squamulatus* Neumann. From unknown host (Dire-Daoua, Abyssinia).

1911. *Hæmatopinus (Linognathus) squamulatus* Neumann, Arch. de Par., Vol. 14, pp. 401-403; f. 1-4.

NOTE: This is neither *Hæmatopinus* nor *Linognathus;* it approaches *Scipio* in certain respects, but possibly represents an undescribed genus.

3—*Hæmodipsus parvus* Kellogg & Ferris. From *Lagidium peruanum* (Peru, South America).

1915. *Hæmodipsus parvus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 30-32, t. f. 12; pl. 2, f. 4; pl. 4, f. 6.

NOTE: This may possibly belong to *Eulinognathus.* The species was described from immature specimens.

Subfamily *Euhæmatopininæ.*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins. Anopl., p. 15 (1908).

Separated from the other subfamilies of the Hæmatopinidæ only because of the three-segmented antennæ.

Genus *Euhæmatopinus* Osborn

Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 186 (1896); Enderlein, Zool. Anz., Vol. 28, pp. 136, 140 (1904); Dalla Torre, Gen. Ins., Anopl., p. 16 (1908); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 46-47 (1915).

Anterior and middle legs of nearly same size; posterior legs much larger and heavier, with broad, heavy claw, and with a stalked, disk-shaped appendage on femur and tibia. No tergal and sternal plates. Pleural plates present.

Type of the genus, *Euhæmatopinus abnormis* Osborn.

1—*Euhæmatopinus abnormis* Osborn. From *Scalopus aquaticus* (Iowa, U. S. A.).

1896. *Euhæmatopinus abnormis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 187.

1908. *Euhæmatopinus abnormis* Dalla Torre, Gen. Ins., Anopl., p. 16.

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1915. *Euhæmatopinus abnormis* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 47-48; t. f. 16; pl. 3, f. 3; pl. 5, f. 4, 9.

Genus *Hæmatopinoides* Osborn.

Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 28 (1891); Bul. 5, n. s., p. 187 (1896); Enderlein, Zool. Anz., Vol. 28, pp. 136, 140 (1904); Dalla Torre, Gen. Ins., Anopl., p. 15 (1908); Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 46 (1915).

Anterior and middle legs small, posterior legs much larger, without stalked, disk-shaped appendages on femur and tibia. Abdomen without chitinized tergal and sternal plates. Pleural plates present.

Type of the genus, *Hæmatopinoides squamosus* Osborn.

1—*Hæmatopinoides squamosus* Osborn. From *Geomys bursarius*. (Iowa, U. S. A.).

1891. *Hæmatopinoides squamosus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 28, f. 16.

1896. *Hæmatopinoides squamosus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 187-188, f. 110.

1908. *Hæmatopinoides squamosus* Dalla Torre, Gen. Ins., Anopl., p. 15.

1915. *Hæmatopinoides squamosus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 46-47.

Family *Echinophthiriidæ*

Echinophthiriidæ Enderlein, Zool. Anz., Vol. 28, pp. 136, 137 (1904); Ibid., Vol. 29, p. 661 (1906); Deut. Südpolar Exp., Vol. 10, pp. 505-506 (1909); Dalla Torre, Gen. Ins., Anopl., p. 17 (1908).

Lepidophthiriidæ (in part) Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 177 (1910).

Antennæ four- or five-segmented. Legs with a thumb-like process opposing the claw, the anterior pair small with slender claw, the other pairs extremely large with blunt, heavy claws. Abdomen without pleural, tergal or sternal plates.

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Thorax and abdomen thickly beset with spines or with spines and delicate scales. Occurring only on marine mammals.

Subfamily *Echinophthiriinæ*

Enderlein, Deut. Südpolar Exp., Vol. 10, p. 506 (1909).

Antennæ four-segmented. Abdomen thickly beset with spines but without scales.

Genus *Echinophthirius* Giebel

Giebel, Zeitschrift f. ges. Naturw., Vol. 37, p. 177 (1871); Piaget, Les Ped., p. 656 (1880); Dalla Torre, Gen. Ins., Anopl., p. 17 (1908); Enderlein, Zool. Anz., Vol. 28, p. 137 (1904); Ibid., Vol. 29, p. 661 (1906); Deut. Südpolar Exp., Vol. 10, p. 507 (1909).

Antennæ four-segmented. Body without scales but thickly beset with stout spines.

From *Pinnipedia.* Type of the genus *Echinophthirius phocæ* (Lucas).

1—*Echinophthirius groenlandicus* (Becker). From *Phoca groenlandica* (Jan Mayen Island).

1886. *Echinophthirius groenlandicus* Becker, Osterreichische Polarforschung, Vol. 3, Ins. von Jan Mayen, p. 60; pl. 5, f. 1-1a.

1908. *Echinophthirius groenlandicus* Dalla Torre, Gen. Ins., Anopl., p. 17.

1909. *Echinophthirius groenlandicus* Enderlein, Deut. Südpolar Exp., Vol. 10, p. 507.

2—*Echinophthirius phocæ* (Lucas). Type from (?) *Phoca vitulina* (Europe). Also from *P. groenlandica, P. variegata* (Atlantic Ocean), "harbor seals" (Aquarium, New York City), and "see hunde" (Helgoland).

1834. *Pediculus phocæ* Lucas, Mag. Zool. Ins., p. 121; pl. 12, f. 1.

1842. *Hæmatopinus setosus* Denny, Mon. Anopl., p. 36.

1857. *Hæmatopinus annulatus* Schilling, Arch. f. Naturgesc., Vol. 23, p. 281.

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1874. *Hæmatopinus setosus* Giebel, Ins. Epizoa, pp. 42-43.
1880. *Echinophthirius setosus* Piaget, Les Ped., pp. 656-658; pl. 54—, f. 1.
1896. *Echinophthirius setosus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 188.
1904. *Echinophthirius phocæ* Enderlein, Zool. Anz., Vol. 28, p. 136.
1908. *Echinophthirius phocæ* Dalla Torre, Gen. Ins., Anopl., p. 17.
1909. *Echinophthirius phocæ* Enderlein, Deut. Südpolar Exp., Vol. 10, p. 507.
1910. *Echinophthirius phocæ* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 176.
1913. *Echinophthirius phocæ* Evans, Proc. Roy. Phys. Soc., Edinburgh, Vol. 19, p. 95, fig.

3—*Echinophthirius sericeus* Meinert. From *Phoca* sp. (Greenland).

1896. *Echinophthirius sericeus* Meinert, Vedenskabelige Meddelelser, p. 177.
1908. *Echinophthirius sericeus* Dalla Torre, Gen. Ins., Anopl., p. 18.

Subfamily *Antarctophthiriinæ*

Enderlein, Deut. Südpolar Exp., Vol. 10, p. 506 (1909).

Antennæ four- or five-segmented. Thorax and abdomen beset with many stout spines and with delicate scales.

Genus *Antarctophthirus* Enderlein

Antarctophthirus Enderlein, Zool. Anz., Vol. 29, p. 661 (1906); Deut. Südpolar Exp., Vol. 10, p. 506 (1909); Dalla Torre, Gen. Ins., Anopl., p. 17 (1908); Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 48 (1915).

Arctophthirus (in part) Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 178-179 (1910).

Antennæ five-segmented. Anterior legs and claws much smaller than the others, which are extraordinarily large and stout. No sternal plate. No pleural plates. Abdomen and

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thorax beset with a great number of short stout spines and with extremely delicate scales. Spiracles small.

From various marine Mammals.

Type of the genus, *Antarctophthirus ogmorhini* Enderlein.

1—*Antarctophthirus lobodontis* Enderlein. From *Lobodon carcinophagus*. (Booth Wandel Is).

1909. *Antarctophthirus lobodontis* Enderlein, Deut. Südpolar Exp., Vol. 10, pt. 4, p. 476.

2—*Antarctophthirus michrochir* (Trouessart & Neumann). From *Phocarctos hookeri* (Auckland Island). Also from *Zalophus californianus* (California), (unpublished record).

1888. *Echinophthirius michrochir* Trouessart & Neumann, Le Naturaliste, Vol. 10, p. 80.

1908. *Echinophthirius michrochir* Dalla Torre, Gen. Ins., Anopl., p. 17.

1909. *Antarctophthirus michrochir* Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 511-512; f. 176, 177, 183, 184.

3—*Antarctophthirus monachus* Kellogg & Ferris. From "seal." Locality unknown.

1915. *Antarctophthirus monachus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 49-51; t. f. 17a, 18; pl. 3, f. 4.

4—*Antarctophthirus ogmorhini* Enderlein. From *Ogmorhinus leptonyx*. (Victoria Land).

1902. *Echinopththirius setosus* Rothschild, Rept. Sou. Cross Exp., p. 224.

1906. *Antarctophthirus ogmorhini* Enderlein, Zool. Anz., Vol. 29, p. 662, f. 1-2.

1907. *Antarctophthirus ogmorhini* (in part) Neumann, Exp. Antarc. Franc. Arth., p. 13.

1908. *Antarctophthirus ogmorhini* Dalla Torre, Gen. Ins., Anopl., p. 17.

1909. *Antarctophthirus ogmorhini* Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 509-510, f. 174, 175, 181, 182.

5—*Antarctophthirus trichechi* (Boheman). Type from *Odobœnus rosmarus* (Europe). Also from *Odobœnus obesus* (Pacific Ocean).

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1866. *Hæmatopinus trichechi* Boheman, Oefversigt af K. Vetenskaps-Akad. Förhandlingar, Vol. 22, p. 577; pl. 35, f. 2.
1880. *Hæmatopinus trichechi* Piaget, Les Ped., p. 656.
1908. *Hæmatopinus trichechi* Dalla Torre, Gen. Ins., Anopl., p. 11.
1909. *Antarctophthirus trichechi* Neumann, Arch. de Par., Vol. 13, pp. 532-537, f. 30-31.
1909. *Antarctophthirus trichechi* Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 502, 512-513; pl. 55-56.
1910. *Arctophthirus trichechi* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 178-180, f. 89-92.
1915. *Antarctophthirus trichechi* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 49, t. f. 17b; pl. 3, f. 1.

Genus *Lepidophthirus* Enderlein

Enderlein, Zool. Anz., Vol. 28, pp. 43, 137 (1904); Ibid., Vol. 29, p. 661 (1905); Dalla Torre, Gen. Ins., Anopl., p. 18 (1908); Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 513-514 (1909).

Antennæ four-segmented. Spiracles present on both meso- and metathorax and on second to eighth abdominal segments. Anterior legs small, others very large. Thorax and abdomen beset with delicate scales and with many spines.

Type of the genus *Lepidophthirus macrorhini* Enderlein.

1—*Lepidophthirus macrorhini* Enderlein. From *Macrorhinus leoninus* (Kerguelen Island).
1904. *Lepidophthirus macrorhini* Enderlein, Zool. Anz., Vol. 28, pp. 46-47, f. 1-5.
1908. *Lepidophthirus macrorhini* Dalla Torre, Gen. Ins., Anopl., p. 18.
1909. *Lepidophthirus macrorhini* Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 515-516, f. 178-180, t. f. OO, QQ.

Family *Hæmatomyzidæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 137 (1904); Dalla Torre, Gen. Ins., Anopl., p. 19 (1908).

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Head much produced anteriorly with the mouth opening at the apex. Antennæ five-segmented. Legs long and slender, of nearly equal size, without a thumb-like process opposing the claw.

Genus *Hæmatomyzus* Piaget

Hæmatomyzus Piaget, Tijds. v. Ent., Vol. 12, p. 254 (1869); Günther, Science Gossip, p. 278 (1871); Piaget, Les Ped., p. 658 (1880); Enderlein, Zool. Anz., Vol. 28, p. 137 (1904); Dalla Torre, Gen. Ins., Anopl., p. 19 (1908).

Idolocoris Walker & Richter, Science Gossip, pp. 131, 211 (1871).

Phantasmocoris White, Science Gossip, pp. 234, 278 (1871).

Head tubularly produced anteriorly, with the mouth opening at the apex. Antennæ five-segmented. Legs long and slender, without a thumb-like process opposing the claw.

Type of the genus, *Hæmatomyzus elephantis* Piaget.

1—*Hæmatomyzus elephantis* Piaget. From African elephant.

1869. *Hæmatomyzus elephantis* Piaget, Tijds. v. Ent., Vol. 4, ser. 2, p. 254; pl. 2, f. 1-14.

1871. *Idolocoris elephantis* Richter, Science Gossip, p. 132, f. 67.

1871. *Hæmatomyzus elephantis* Newman, The Entomologist, Vol. 6, pp. 465-470, fig.

1880. *Hæmatomyzus proboscideus* Piaget, Les Ped., pp. 658-660; pl. 54, f. 2.

1908. *Hæmatomyzus elephantis* Dalla Torre, Gen. Ins., Anopl., p. 19.

1910. *Hæmatomyzus proboscideus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 181-183, f. 93.

1a—*Hæmatomyzus elephantis* var. *sumatranus* Fahrenholz. From *Elephas indicus* (Sumatra).

1910. *Hæmatomyzus elephantis* var. *sumatranus* Fahrenholz, Zool. Anz., Vol. 35, p. 714.

1910. *Hæmatomyzus elephantis* var. *sumatranus* Fahrenholz, Jahresb. d. Niedersäch. Zool. Ver., Vol. 58-59, Abt. D, p. 67.

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HOST LIST OF THE ANOPLURA

The arrangement of the orders is that adopted by Osborn in "The Age of Mammals" (1914). In each case the first name given is the correct name, as nearly as it has been possible to establish it. The names in parentheses are synonyms that have been used in connection with discussions of the Anoplura.

Order INSECTIVORA

Family TALPIDÆ

Scalopus aquaticus machrinus? (Scalops argentatus).
Euhæmatopinus abnormis Osborn (Ames, Iowa, U. S. A.).

Family SORICIDÆ

Sorex araneus (Sorex vulgaris).
Polyplax reclinatus (Burm.) (Europe).
?Hoplopleura acanthopus (Burm.) (Europe).

Order CARNIVORA

Suborder FISSIPEDIA

Family CANIDÆ

Canis familiaris (Domestic dog).
Linognathus piliferus (Burm.) (Cosmopolitan).

Family MUSTELIDÆ

"Ferret."
Linognathus piliferus (Burm.) (England).

Suborder PINNIPEDIA

Family ODOBÆNIDÆ

Odobænus rosmarus (Trichechus rosmarus, Walrus).
Antarctophthirus trichechi (Boh.) (North Atlantic).
Odobænus obesus (Pacific Walrus).
Antarctophthirus trichechi (Boh.) (North Pacific).

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Family PHOCIDÆ

Phoca groenlandica.
Echinophthirius groenlandica (Becker) (Jan Mayen Island).
Phoca variegata.
Echinophthirius phocæ (Lucas) (Europe).
Phoca vitulina.
Echinophthirius phocæ (Lucas) (Europe).
Phoca sp.
Echinophthirius sericeus Meinert (Greenland).
Macrorhinus leoninus.
Lepidophthirus macrorhini End. (Victorialand).
Lobodon carcinophaga.
Antarctophthirus lobodontis End. (Booth Wandel Is.).
Ogmorhinus leptonyx.
Antarctophthirus ogmorhini End. (Kerguelen Is.).

Family OTARIIDÆ

Phocarctos hookeri.
Antarctophthirus microchir (Troues. & Neum.) (Auckland Is.).
Zalophus californianus.
Antarctophthirus microchir (Troues. & Neum.) (California).

Of Uncertain Position

"Harbor Seal."
Echinophthirius phocæ (Lucas) (Aquarium, New York City).
"Seal."
Antarctophthirus monachus Kellogg & Ferris (Locality unknown).
"Seehunde."
Echinophthirius phocæ (Lucas) (Helgoland).

Order RODENTIA

Suborder DUPLICIDENTATA

Family LEPORIDÆ

Lepus californicus.
Hæmodipsus ventricosus (Denny) (California, U. S. A.).

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Lepus californicus deserticola.
Hæmodipsus ventricosus (Denny) (Ehrenberg, Arizona, U. S. A.).
Lepus campestris (Prairie Hare).
Hæmodipsus ventricosus (Denny) (Ames, Iowa, U. S. A.).
Lepus europaeus occidentalis (Lepus europaeus).
Hæmodipsus lyriocephalus (Burm.) (Tyninghame, Scotland).
Lepus timidus.
Hæmodipsus ventricosus (Denny) (Europe).
Hæmodipsus lyriocephalus (Burm.) (Europe).
Oryctolagus cuniculus (Kaninchen, Lepus cuniculus).
Hæmodipsus ventricosus (Denny) (Europe).
"Domestic rabbit."
Hæmodipsus ventricosus (Denny) (Europe, North America).

Suborder Simplicidentata

Family Sciuridæ

Subfamily Arctomyinæ

Ammospermophilus nelsoni.
Enderleinellus suturalis (Osborn) (Bakersfield, California, U. S. A.).
Callospermophilus chrysodeirus.
Enderleinellus suturalis var. occidentalis K. & F. (South Yolla Bolly Mt. and Yosemite Valley, California, U. S. A.).
Citellus barrowensis ? (Spermophilus sp.).
Linognathoides montanus (Osborn) (Pt. Barrow, Alaska).
Citellus beecheyi beecheyi (Citellus beecheyi douglasi).
Linognathoides montanus (Osborn) (Palo Alto, California, U. S. A.).
Enderleinellus osborni K. & F. (Palo Alto, California, U. S. A.).
Citellus beldingi.
Enderleinellus suturalis (Osborn) (Yosemite Nat. Park, California, U. S. A.).
Linognathoides montanus (Osborn) (California, U. S. A.).

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Citellus columbianus (Spermophilus columbianus).
Linognathoides montanus (Osborn) (Pullman, Washington, U. S. A.).
Citellus douglasi (Citellus beecheyi douglasi).
Enderleinellus osborni K. & F. (Cazadero, California, U. S. A.).
Linognathoides montanus (Osborn) (Cazadero, California, U. S. A.).
Citellus eversmanni (Spermophilus eversmanni).
Linognathoides læviusculus (Grube) (Jakutsk, Siberia; Pitlekaj).
Citellus franklini (Spermophilus franklini).
Enderleinellus suturalis (Osborn) (Ames, Iowa, U. S. A.).
Citellus grammurus.
Linognathoides montanus (Osborn) (Santa Catalina Mts., Arizona, U. S. A.).
Citellus leptodactylus.
Linognathoides citelli Cum. (Transcaspia).
Citellus mexicanus ?
Linognathoides montanus (Osborn) (Guanajuato, Mexico).
Citellus mollis.
Enderleinellus suturalis (Osborn) (Virginia Valley, Nevada, U. S. A.).
Citellus oregonus.
Enderleinellus suturalis (Osborn) (Pine Forest Mts., Nevada, U. S. A.).
Linognathoides montanus (Osborn).
Citellus plesius ablusus.
Linognathoides montanus (Osborn) (Prince William Sound, Alaska).
Citellus townsendi.
Enderleinellus suturalis (Osborn) (Wallula, Washington, U. S. A.).
Citellus tridecemlineatus (Spermophilus tridecemlineatus).
Enderleinellus suturalis (Osborn) (Ames, Iowa, U. S. A.).
Citellus sp. ? ("Rock Squirrel").
Linognathoides montanus (Osborn) (Boulder, Colorado, U. S. A.).

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Citellus sp. ? ("Western Gray Squirrel").
Linognathoides montanus (Osborn) (Ft. Collins, Colorado, U. S. A.).
Cynomys gunnisoni.
Enderleinellus suturalis (Osborn) (Florissant, Colorado, U. S. A.).
Cynomys leucurus.
Enderleinellus suturalis (Osborn) (Routt County, Colorado, U. S. A.).
Marmota flaviventer sierræ.
Linognathoides montanus (Osborn) (California, U. S. A.).
Marmota flaviventer ssp. ?
Linognathoides montanus (Osborn) (Burns, Oregon, U. S. A.).
Marmota pruinosa.
Linognathoides sp. (North America).
Xerospermophilus tereticaudus.
Enderleinellus suturalis (Osborn) (Imperial County, California, U. S. A.).

Subfamily SCIURINÆ

Sciurus arizonensis huachuca.
Enderleinellus longiceps K. & F. (Huachuca Mts., Arizona, U. S. A.).
Sciurus douglasi albolimbatus.
Enderleinellus sphærocephalus (Nitzsch) (Yosemite Nat. Park, California, U. S. A.).
Hoplopleura arboricola K. & F. (Yosemite Nat. Park, California, U. S. A.).
Neohæmatopinus antennatus var. semifasciatus Ferris (Yosemite Nat. Park, California, U. S. A.).
Sciurus douglasi mollipilosus.
Hoplopleura arboricola K. & F. (Cazadero, California, U. S. A.).
Neohæmatopinus antennatus var. semifasciatus Ferris (Cazadero, California, U. S. A.).

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Sciurus griseus griseus.
- Enderleinellus kelloggi Ferris (Mariposa County, California, U. S. A.).
- Hoplopleura arboricola K. & F. (Mariposa County, California, U. S. A.).
- Neohæmatopinus antennatus (Osborn) (Mariposa County, California, U. S. A.).

Sciurus griseus nigripes.
- Enderleinellus kelloggi Ferris (Stanford University, California, U. S. A.).
- Hoplopleura arboricola K. & F. (Stanford University, California, U. S. A.).

Sciurus hudsonicus petulans.
- Enderleinellus sphærocephalus (Burm.) (Glacier Bay, Alaska).

Sciurus hudsonicus vancouverensis.
- Enderleinellus sphærocephalus (Burm.) (Kuiu Island, Alaska).

Sciurus niger rufiventer (Sciurus cinereus ludovicianus).
- Enderleinellus longiceps K. & F. (De Kalb County, Indiana, U. S. A.).
- Neohæmatopinus antennatus (Osborn) (Ames, Iowa, U. S. A.).

Sciurus palmarum.
- Hoplopleura maniculata (Neum.) (Rajkote, India).
- Neohæmatopinus echinatus (Neum.) (Rajkote, India).

Sciurus vulgaris.
- Enderleinellus sphærocephalus (Burm.) (Europe).

Sciurus niger ? (Sciurus vulpinus).
- Neohæmatopinus sciurinus (Mjöberg) (Zool. Mus. Hamburg).

Sciurus niger rufiventer or S. carolinensis carolinensis ("Western Gray Squirrel").
- Enderleinellus longiceps K. & F. (Lincoln, Nebraska, U. S. A.).

Tamias striatus.
- Hoplopleura arboricola K. & F. (Ames, Iowa, U. S. A.).
- Hoplopleura erratica (Osborn) (= H. arboricola K. & F.?) (Iowa, U. S. A.).

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Eutamias alpinus.
Neohæmatopinus pacificus K. & F. (Yosemite Nat. Park, California, U. S. A.).
Hoplopleura arboricola K. & F. (Yosemite Nat. Park, California, U. S. A.).
Eutamias hindsi.
Neohæmatopinus pacificus K. & F. (Marin County, California, U. S. A.).
Eutamias merriami pricei
Hoplopleura arboricola K. & F. (Stanford University, California, U. S. A.).
Eutamias speciosus frater.
Hoplopleura arboricola K. & F. (Yosemite Nat. Park, California, U. S. A.).
Neohæmatopinus pacificus K. & F. (Yosemite Nat. Park, California, U. S. A.).
Eutamias sonomæ.
Neohæmatopinus pacificus K. & F. (Cazadero, Sonoma County, and Sanhedrin Mt., Mendocino County, California, U. S. A.).
Hoplopleura arboricola K. & F. (Cazadero, Sonoma County, and Sanhedrin Mt., Mendocino County, California, U. S. A.).
Eutamias townsendi ochrogenys.
Hoplopleura arboricola K. & F. (Freestone and Cazadero, Sonoma County, California, U. S. A.).
Neohæmatopinus pacificus K. & F. (Freestone and Cazadero, Sonoma County, California, U. S. A.).
Heliosciurus palliatus.
Neohæmatopinus heliosciuri Cumm. (Uchweni Forest, Witu, British East Africa).

Subfamily XERINÆ

Xerus getulus.
Linognathoides pectinifer (Neum.) (Northern Africa).

Family PETAURISTIDÆ

Glaucomys sabrinus ssp. (Sciuropterus sp.)
Hoplopleura trispinosa K. & F. (Eureka, California, and Brownsville, Oregon, U. S. A.).

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Glaucomys sabrinus lascivus.
Enderleinellus uncinatus Ferris (Yosemite Nat. Park, California, U. S. A.).
Hoplopleura trispinosa K. & F. (Yosemite Nat. Park, California, U. S. A.).
Neohæmatopinus sciuropteri (Osborn) (Yosemite Nat. Park, California, U. S. A.).
Glaucomys volans (Sciuropterus volucella, Pteromys volucella)
Hoplopleura trispinosa K. & F. (Kensington, Maryland, U. S. A.).
Hoplopleura erratica (Osborn) (= H. trispinosa K. & F.?) (Iowa, U. S. A.).
Neohæmatopinus sciuropteri (Osborn) (Iowa, U. S. A.).

Family Heteromyidæ

Dipodomys deserti.
Fahrenholzia pinnata K. & F. (Mecca, Riverside County, California, U. S. A.).
Dipodomys californicus.
Fahrenholzia pinnata K. & F. (Covelo, California, U. S. A.).
Dipodomys merriami.
Fahrenholzia pinnata K. & F. (Inyo County, California, U. S. A.).
Microdipodops polionotus.
Fahrenholzia pinnata K. & F. (Benton, Mono County, California, U. S. A.).
Perognathus californicus.
Fahrenholzia tribulosa Ferris (Mariposa County, California, U. S. A.).
Perognathus formosus.
Fahrenholzia tribulosa Ferris (Victorville, California, U. S. A.).
Perognathus parvus olivaceus.
Fahrenholzia pinnata K. & F. (Pine Forest Mts., Nevada, U. S. A.).
Perodipus sp.
Fahrenholzia pinnata K. & F. (Coulterville, Mariposa County, California, U. S. A.)

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Family Geomyidæ

Geomys bursarius.
Hæmatopinoides squamosus Osborn (Ames, Iowa, U. S. A.).

Family Muscardinidæ

Dryomys nitedula (Myoxus nitella).
Polyplax pleurophæa (Burm.) (Europe).

Family Muridæ

Subfamily Murinæ

Cricetulus phæus.
Linognathoides citelli Cumm. (Transcaspia).
Note: Cricetulus is probably not the normal host of this species.
Mus musculus.
Polyplax serrata (Burm.) (Europe).
Hoplopleura acanthopus (Burm.) (Europe).
Hoplopleura hesperomydis (Osborn) (California, U. S. A.).
Mus chrysophilus.
Polyplax gracilis Fahr. (Mfongosi, Zululand, South Africa).
Mus coucha.
Hoplopleura intermedia K. & F. (Mfongosi, Zululand, South Africa).
Mus barbarus.
Polyplax ? spiculifera (Gerv.) (Algiers).
Apodemus agrarius (Mus agrarius).
Polyplax affinis (Burm.) (Europe).
Apodemus sylvaticus (Mus sylvaticus).
Polyplax affinis (Burm.) (Europe).
Polyplax spinulosa (Burm.) (Europe).
Micromys minutus (Mus minutus).
Hoplopleura longula (Neum.).
Polyplax gracilis Fahr. (Europe).
Epimys norvegicus (Mus norvegicus, Mus decumanus, Wanderratte).
Polyplax spinulosa (Burm.) (Cosmopolitan).

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Epimys rattus (Mus rattus).
Polyplax spinulosa (Burm.) (Cosmopolitan).
Hoplopleura bidentata (Neum.) (Lake Torrens, Australia).
Epimys rattus alexandrinus (Mus alexandrinus).
Polyplax spinulosa (Burm.).
Epimys surifer.
Polyplax pectinata Cumm. (Biserat, Jalor, Malay Peninsula).
Acomys caharinus.
Polyplax brachyrrhynchus Cumm. (Assiut, Egypt).
Polyplax oxyrrhynchus Cumm. (Assiut, Egypt).
Arvicanthis dorsalis.
Hoplopleura enormis K. & F. (Mfongosi, Zululand, South Africa).
Dasymys incomtus Ferris.
Polyplax cummingsi Ferris (Mfongosi, Zululand, South Africa).
Saccostomus campestris.
Polyplax jonesi K. & F. (Mfongosi, Zululand, South Africa).

Subfamily GERBILLINÆ

Gerbillus indicus.
Polyplax stephensi (Christ. & News.) (India).
Meriones sp.
Polyplax ? clavicornis (Nitzsch) (Abyssinia).
Pachyuromys duprasi.
Polyplax werneri (Glink.) (Natrontal, Egypt).

Subfamily OTOMYINÆ

Otomys brantsi luteolus.
Polyplax otomydis Cumm. (South African Museum, Cape Town).
Otomys irroratus.
Polyplax otomydis Cumm. (Mfongosi, Zululand, South Africa).
Otomys irroratus tropicalis.
Polyplax otomydis Cumm. (Mt. Kenya, British East Africa).

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Subfamily Microtinæ

Arvicola amphibius (Paludicola amphibius).
Polyplax spiniger (Burm.) (Europe).
Dicrostonyx torquatus (Lemmus torquatus).
Hoplopleura acanthopus (Burm.) (Pitlekaj).
Lemmus obensis.
Hoplopleura hispida (Grube) (Jakutsk, Siberia).
Microtus agrestis.
Hoplopleura acanthopus (Burm.) (Europe).
Microtus arvalis.
Hoplopleura acanthopus (Burm.) (Europe).
Microtus californicus.
Polyplax spinulosa (Burm.).
Hoplopleura acanthopus var. americanus K. & F.
Microtus mordax.
Polyplax spinulosa (Burm.) (Tuolumne Meadows, California, U. S. A.).
Microtus nivalis.
Polyplax villosa Galli-Valerio (Switzerland).
Microtus (Lagurus) intermedius.
Hoplopleura acanthopus var. americanus K. & F.
Polyplax spinulosa (Burm.) (Pine Forest Mts., Nevada, U. S. A.).
Microtus pennsylvanicus (Arvicola pennsylvanica).
Hoplopleura erratica (Osborn).
Microtus sp. (Arvicola sp.).
Hoplopleura acanthopus var. americanus K. & F. (Ames, Iowa, U. S. A.).
Phenacomys longicaudus (Phenacomys sp.).
Polyplax spinulosa (Burm.) (Mendocino City, California, U. S. A.).

Subfamily Cricetinæ

Holochilus squamipes. (This is possibly Nectomys apicalis).
Hoplopleura quadridentata (Neum.) (Perú, South America).
Neotoma cinerea cinerea.
Linognathoides inornatus K. & F. (Yosemite Nat. Park, California, U. S. A.).

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Neotoma cinerea occidentalis.
Linognathoides inornatus K. & F. (South Yolla Bolly Mt., Tehama County, California, U. S. A.).
Neotoma fuscipes streatori.
?Linognathoides inornatus K. & F. (Yosemite Nat. Park, California, U. S. A.).
Nesoryzomys indefessus.
Hoplopleura quadridentata (Neum.) (Galapagos Is.).
Nesoryzomys narboroughi.
Hoplopleura quadridentata (Neum.) (Galapagos Is.).
Peromyscus boylei.
Hoplopleura hesperomydis (Osborn) (Lakeport, Lake County, California, U. S. A.).
Peromyscus maniculatus rubidus.
Hoplopleura hesperomydis (Osborn).
Polyplax auricularis K. & F. (Marin County, California, U. S. A.).
Peromyscus maniculatus gambeli.
Hoplopleura hesperomydis (Osborn).
Polyplax auricularis K. & F. (Yosemite Nat. Park, California, U. S. A.).
Peromyscus sitchensis prevostensis.
Polyplax auricularis K. & F. (Forrester Is., Alaska).
Onychomys leucogaster arcticeps.
Hoplopleura hesperomydis (Osborn) (Colorado Springs, Colorado, U. S. A.).
Polyplax auricularis K. & F. (Colorado Springs, Colorado, U. S. A.).
Onychomys torridus pulcher.
Hoplopleura hesperomydis (Osborn) (Victorville, California, U. S. A.).
Polyplax auricularis K. & F. (Victorville, California, U. S. A.).
Sigmodon hispidus.
Hoplopleura hirsuta Ferris (Raleigh, North Carolina, U. S. A.).
Sigmodon hispidus texianus.
Hoplopleura hirsuta Ferris (Lakeport, Texas, U. S. A.).
Sigmodon hispidus eremicus.
Hoplopleura hispidus Ferris (Saçaton, Arizona, U. S. A.).

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Muridæ of Uncertain Position

"Einer kleinen ratte mit sehr dicken, stachelartigen Haaren."
Polyplax miacantha Speiser (Salomona, Abyssinia).
"Gros Rats."
Polyplax ? præcisa Neumann (Abyssinia).

Family DIPODIDÆ

Dipus sp.
Eulinognathus aculeatus (Neum.) (Tunis).

Family PEDETIDÆ

Pedetes caffer.
Eulinognathus denticulatus Cumm. (South Africa).

Family OCTODONTIDÆ

Thryonomys swinderianus (Aulacodus swinderianus).
Scipio aulacodi (Neum.) (Dahomey; Luangwa Valley, Northeastern Rhodesia, Africa).
Thryonomys sp.
Scipio aulacodi (Neum.) (Mfongosi, Zululand, South Africa).
Scipio breviceps Ferris (Mfongosi, Zululand, South Africa).

Family CHINCHILLIDÆ

Lagidium peruanum.
Hæmodipsus ? parvus Kellogg & Ferris (Peru, South America).

Order TUBULIDENTATA

Family ORYCTEROPODIDÆ

Orycteropus afer.
Hobophthirus notophallus (Neum.) (South Africa).

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Order PRIMATES

Family LASIOPYGIDÆ

Lasiopyga mona (Cercopithecus mona).
  Pedicinus breviceps Piaget.
Pithecus albibarbatus (Macacus silenus).
  Pedicinus breviceps Piaget (Zool. Mus. Hamburg).
  Pedicinus paralleliceps Mjöberg (Zool. Mus. Hamburg).
Pithecus brevicaudus or P. rhesus (Macacus erythræus).
  Phthirpedicinus piageti (Stroebelt).
Pithecus nemestrinus (Inuus nemestrinus).
  Pedicinus eurygaster Gerv.
Pithecus rhesus (Macacus rhesus).
  Pedicinus rhesi Fahr.
  Phthirpedicinus micropilosus Fahr.
Pithecus sinicus (Inuus sinicus).
  Phthirpedicinus microps (Nitzsch).
Pithecus irus (Cercopithecus cynomolgus).
  Pedicinus longiceps Piaget.
Pithecus fascicularis (Macacus cynomolgus).
  Pedicinus eurygaster Burm.
Pygathrix cristata (Semnopithecus prunosus).
  Pedicinus longiceps Piaget.
Pygathrix aurata (Trachypithecus maurus).
  Hæmatopinus (Pedicinus or Phthirpedicinus) ? obtusus Rudow.
Simia sylvanus (Inuus sylvanus).
  Hæmatopinus (Pedicinus or Phthirpedicinus) ? albidus Rudow.

Family CEBIDÆ

Ateleus ater (Ateles ater).
  Pediculus capitis De Geer.
Ateleus paniscus (Ateles pentadactylus).
  Pediculus consobrinus Piaget.
Cebus fatuellus.
  Pediculus capitis (De Geer) (Rio de Janeiro, South America).
Cebus sp.
  Pediculus capitis (De Geer).

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Ateleus pan (Ateles rellerosus).
Pediculus lobatus Fahr. (Berlin Mus.).

Family HYLOBATIDÆ

Hylobates concolor (Hylobates mülleri).
Pediculus oblongus Fahr.
Symphalangus syndactylus (Hylobates syndactylus).
Pediculus oblongus Fahr.

Family PONGIDÆ

Pan sp. (Simia troglodytes).
Pediculus schäffi Fahr.

Family HOMINIDÆ

Homo sapiens.
Pediculus capitis De Geer.
Pediculus corporis De Geer.
Phthirus pubis Linnæus.

Primates of Uncertain Position

Cercopithecus sp.
Pedicinus breviceps Piaget (Zool. Mus. Hamburg).
Ateles ape?
Pediculus mjöbergi K. & F. (Traveling menagerie, Europe).
Hamadryas sp. (perhaps a Papio).
Pedicinus hamadryas.
Host entirely unknown but undoubtedly a Primate.
Pedicinus ? graciliceps Piaget.

Order ARTIODACTYLA

Family SUIDÆ

Phachochoerus æthiopicus.
Hæmatopinus phachochoeri End. (Nyasa Land, Africa).
Phachochoerus oeliani massaicus.
Hæmatopinus phachochoeri End. (Africa).

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Phachochoerus sp.
Hæmatopinus phachochoeri End. (Africa).
Potomochoerus affinis nyasæ.
Hæmatopinus phachochoeri End. (German East Africa).
Potomachoerus africanus.
Hæmatopinus phachochoeri End. (Africa).
Potomachoerus choerapotamus.
Hæmatopinus phachochoeri End. (Zululand, South Africa).
Sus scrofa domestica.
Hæmatopinus suis L. (Cosmopolitan).
Sus vittatus.
Hæmatopinus suis adventicius Neum. (East Indies).

Family CAMELIDÆ

Auchenia huanaca (Llama).
Linognathus prælongiceps (Neum.) (South America).
Camelus dromedarius.
Hæmatopinus tuberculatus (Burm.) (Australia, imported from India).
Camelus bactrianus.
Hæmatopinus tuberculatus (Burm.)
African camels.
Hæmatopinus tuberculatus (Burm.) (Cairo, Egypt).

Family GIRAFFIDÆ

Camelopardalis giraffa.
Linognathus brevicornis (Giebel) (Africa).

Family CERVIDÆ

Cervus elaphus.
Cervophthirius crassicornis (Nitzsch) (Europe).
Cervus unicolor.
Hæmatopinus longus Neum. (Nepaul, India).
Odocoileus columbianus.
Cervophthirius crassicornis (Nitzsch) (Laytonville, California, U. S. A.).
Rangifer tarandus.
Cervophthirius tarandi Mjöb. (Sweden).
Cearrus-Hirsch.
? Linognathus breviceps (Piaget) (Guatemala).

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Family Bovidæ

Subfamily Cephalophinæ

Cephalophus maxwelli.
Linognathus breviceps (Piaget).
Cephalophus natalensis.
Linognathus angulatus (Piaget) (Mfongosi, Zululand, S. Africa).
Cephalophus nigrifrons.
Linognathus angulatus (Piaget).
Cephalophus sp.
Linognathus angulatus (Piaget) (Zool. Mus. Hamburg).

Subfamily Cervicaprinæ

Cervicapra arundinum.
Linognathus fahrenholzi Paine (Nyassa Land, Africa).
Cervicapra fulvorufula.
Linognathus fahrenholzi Paine (Mfongosi, Zululand, South Africa).

Subfamily Antilopinæ

Antilope cervicapra.
Linognathus tibialis var. cervicapræ (Lucas).
Antilope euchore.
Linognathus tibialis var. euchore Wat. (South African Museum, Cape Town).
Antilope maori.
Linognathus tibialis (Piaget) (Zoological Garden, Rotterdam).
Antilope rupicapræ.
Linognathus stenopsis (Burm.).
Antilope sp.
Linognathus tibialis var. antennatus (Piaget).
Gazella subgutturosa (Antilope subgutturosa).
Linognathus tibialis var. appendiculatus (Piaget) (Zoological Garden, Rotterdam).
Gazelle.
Linognathus gazella Mjöberg (Zool. Mus. Hamburg).

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Subfamily TRAGELAPHINÆ

Taurotragus oryx.
Hæmatopinus taurotragi Cumm. (Menagerie in England).
Limnotragus gratus.
Linognathus limnotragi Cumm. (Zool. Garden, London, from Congo).

Subfamily RUPICAPRINÆ

Rupicapra rupicapra (Gemse).
Linognathus rupicapræ (Rudow) (Europe).

Subfamily CAPRINÆ

Capra ibex.
Linognathus forficulus (Rudow) (Europe).
Capra ægyptica (Name does not appear in any lists, is possibly C. ægagrus).
Linognathus stenopsis (Burm.).
Capra hircus.
Linognathus stenopsis (Burm.).
"Mexican Goat."
Linognathus stenopsis (Burm.) (San Diego, California, U. S. A.).
Ovis aries.
Linognathus ovillus (Neum.) (Scotland and New Zealand).
Linognathus pedalis (Osborn) (Minnesota, Iowa, Nevada, U. S. A.).
Sheep.
Linognathus stenopsis (Burm.) (Abeokuta, Southern Nigeria, Africa).

Subfamily BOVINÆ

Bos taurus.
Hæmatopinus eurysternus (Nitzsch) (Cosmopolitan).
Linognathus vituli (L.) (Cosmopolitan).
Bos grunniens.
Hæmatopinus punctatus Rudow.

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Bos caffer (Buffelus caffer).
Hæmatopinus bufali (De Geer) (Africa).
Bison bison.
Hæmatopinus tuberculatus (Burm.) (North America).
"Common Buffalo."
Hæmatopinus tuberculatus (Burm.) (Vienna).
"Buffalo of India, Tonkin, Sumatra and Rumania."
Hæmatopinus tuberculatus (Burm.).

Order PERISSODACTYLA

Equus caballus (Domestic horse).
Hæmatopinus asini (L.) (Cosmopolitan).
Equus asinus (Ass).
Hæmatopinus asini (L.).
Equus burchelli.
Hæmatopinus asini (L.) (South Africa).

Order PROBOSCIDEA

Family Elephantidæ

Elephas indicus.
Hæmatomyzus elephantis var. sumatranus Fahr. (Sumatra).
Loxodonta africana (Elephas africanus).
Hæmatomyzus elephantis Piaget.

Order HYRACOIDEA

Family Procaviidæ

Procavia capensis (Hyrax capensis).
Linognathus caviæ-capensis (Pallas) (South Africa).
Procavia syriaca (Hyrax syriacus).
Linognathus leptocephalus (Ehrenb.) (Syria).

Host Unknown

Hæmatopinus (Linognathus) ? squamulatus Neum. (Diri-Daoua, Abyssinia).

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APPENDIX

Since the preceding pages were sent to press the author has received from Mr. Bruce Cummings, of the British Museum, and Mr. James Waterston, of the Imperial Bureau of Entomology, certain notes which are here appended. To both these gentlemen thanks are due.

The addition of these notes makes the Catalogue complete to April 1, 1916.

Linognathus microcephalus (Garnett). From domestic sheep (New Zealand).

NOTE: "This is in my opinion the same as *Linognathus pedalis* (Osb.)" (Waterston).

1915. *Hæmatopinus microcephalus* Garnett, Jour. Comp. Pathology and Therapeutics, pp. 2-3, 3 figs.

Linognathus pithodes Cummings. From *Antilope cervicapra* (Zool. Garden, London).

1916. *Linognathus pithodes* Cummings, Proc. Zool. Soc., London (March, 1916).

Hoplopleura pectinata (Cummings).

NOTE: "*Polyplax pectinata* Cum., is a *Hoplopleura*" (Cummings).

Echinophthirius horridus (Olfers).

1816. *Pediculus horridus* Olfers, De Vegatativis et Animalis.

NOTE: "*Echinophthirius phocæ* Lucas, equals *E. horridus* (Olfers)" (Cummings).

Hoplopleura bidentata (Neum.). From *Hydromys chrysogaster;* not from *Epimys rattus* (Harrison).

Linognathus setosus (Olfers).

1816. *Pediculus setosus* Olfers, De Vegetativis et Animalis.

NOTE: "*Linognathus piliferus* (Burm.) equals *Pediculus setosus* Olfers" (Harrison).

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Pages 129–152. V. Reptiles and Amphibians of the Islands of the West Coast of North America. By John Van Denburgh and Joseph R. Slevin. (*Issued December 30, 1914*) ..... .25

Pages 153–160. VI. The Pocket Gopher of the Boreal Zone on San Jacinto Peak. By J. Grinnell and H. S. Swarth. (*Issued December 30, 1914*) ..... .25

VOLUME V

Pages 1–31. I. Report of the President of the Academy for the year 1914.

II. Report of the Director of the Museum for the year 1914. (*Issued March 26, 1915*) ..... .25

Pages 33–98. III. Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington. By Roy E. Dickerson. Plates I–XI. (*Issued June 15, 1915*) ..... .50

Pages 99–110. IV. A list of the Amphibians and Reptiles of Utah, with Notes on the Species in the Collection of the Academy. By John Van Denburgh and Joseph R. Slevin. Plates XII–XIV. (*Issued June 15, 1915*) ..... .25

Pages 111–161. V. Description of a new subgenus (Arborimus) of Phenacomys, with a Contribution to Knowledge of the Habits and Distribution of Phenacomys longicaudus. By Walter P. Taylor. Plate XV. (*Issued December 30, 1915*) ..... .50

Pages 163–193. VI. Tertiary Deposits of Northeastern Mexico. By E. T. Dumble. Plates XVI and XIX. (*Issued December 31, 1915*). .50

Pages 195–223. VII. Report of the President of the Academy for the Year 1915.

VIII. Report of the Director of the Museum for the Year 1915. (*Issued May 4, 1916*) ... .25

VOLUME VI

Pages 1–17. I. Eocene of Lower Cowlitz River Valley, Washington. By Charles E. Weaver. Plate 1. (*Issued May 6, 1916*).

Pages 19–40. II. The Post-Eocene Formations of Western Washington. By Charles E. Weaver. (*Issued May 6, 1916*).

Pages 41–52. III. The Oligocene of Kitsap County, Washington. By Charles E. Weaver. (*Issued May 6, 1916*). Price for the three papers ..... .50

Pages 53–85. IV. The Pacific Coast Races of the Bewick Wren. By Harry S. Swarth. Plate 2. (*Issued May 8, 1916*) ..... .35

Pages 87–128. V. Monograph of the North American Species of Orthotylus (Hemiptera). By Edward P. Van Duzee. (*Issued May 8, 1916*) ..... .50

Pages 129–213. VI. A Catalogue and Host List of the Anoplura. By G. F. Ferris. (*Issued May 12, 1916*) ..... .50

The Academy cannot supply any of its publications issued before the year 1907, its entire reserve stock having been destroyed in the conflagration of April, 1906.

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PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. VI, Nos. 8 and 9, pp. 223–294, pls. 3–17. JUNE 23, 1917

VIII

Report of the President of the Academy for the Year 1916

BY

C. E. GRUNSKY

President of the Academy

IX

Report of the Director of the Museum for the Year 1916

BY

BARTON WARREN EVERMANN

Director of the Museum

SAN FRANCISCO

PUBLISHED BY THE ACADEMY

1917

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COMMITTEE ON PUBLICATION

GEORGE C. EDWARDS, *Chairman*

C. E. GRUNSKY — BARTON WARREN EVERMANN, *Editor*

PROCEEDINGS

Fourth Series

VOLUME I

Expedition of the California Academy of Sciences to the Galapagos Islands, 1905-1906.

Pages 1–6. I. Preliminary Description of Four New Races of Gigantic Land Tortoises from the Galapagos Islands. By John Van Denburgh. (*Issued December 20, 1907*)..... $ .25

Pages 7–288. II. A Botanical Survey of the Galapagos Islands. By Alban Stewart. Plates I–XIX. (*Issued January 20, 1911*)... 1.75

Pages 289–322. III. The Butterflies and Hawk-Moths of the Galapagos Islands. By Francis X. Williams. Plates XX–XXI. (*Issued October 7, 1911*)..... .50

Pages 323–374. IV. The Snakes of the Galapagos Islands. By John Van Denburgh. Plates XXII–XXX. (*Issued January 17, 1912*) .50

Pages 375–404. V. Notes on the Botany of Cocos Island. By Alban Stewart. Plates XXXI–XXXIV. (*Issued January 19, 1912*) .35

Pages 405–430. VI. The Geckos of the Galapagos Archipelago. By John Van Denburgh. (*Issued April 16, 1912*)..... .35

Pages 431–446. VII. Notes on the Lichens of the Galapagos Islands. By Alban Stewart. (*Issued December 17, 1912*)..... .25

VOLUME II, PART I

Expedition of the California Academy of Sciences to the Galapagos Islands, 1905-1906.

Pages 1–132. VIII. The Birds of the Galapagos Islands, with Observations on the Birds of Cocos and Clipperton Islands (Columbiformes to Pelecaniformes). By Edward Winslow Gifford. Plates I–VII. (*Issued August 11, 1913*)..... 1.00

Pages 133–202. IX. The Galapagoan Lizards of the Genus Tropidurus; with Notes on the Iguanas of the Genera Conolophus and Amblyrhyncus. By John Van Denburgh and Joseph R. Slevin. Plates VIII–XI. (*Issued September 19, 1913*). .50

Pages 203–374. X. The Gigantic Land Tortoises of the Galapagos Archipelago. By John Van Denburgh. Plates XII–CXXIV. (*Issued September 30, 1914*)..... 2.00

VOLUME III

Pages 1–40. A Further Stratigraphic Study in the Mount Diablo Range of California. By Frank M. Anderson. Plate I. (*Issued October 31, 1908*)..... .35

Pages 41–48. Description of a New Species of Sea Snake from the Philippine Islands, with a Note on the Palatine Teeth in the Proteroglypha. By John Van Denburgh and Joseph C. Thompson. (*Issued December 31, 1908*)..... .25

Pages 49–56. New and Previously Unrecorded Species of Reptiles and Amphibians from the Island of Formosa. By John Van Denburgh. (*Issued December 20, 1909*)..... .25

Pages 57–72. Water Birds of the Vicinity of Point Pinos, California. By Rollo Howard Beck. (*Issued September 17, 1910*)..... .25

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PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. VI, Nos. 8 and 9, pp. 223-294, pls. 3–17. JUNE 23, 1917

VIII

REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1916

BY

C. E. GRUNSKY

President of the Academy

In view of the fact that the work of the California Academy of Sciences, its purposes and aims, were rather fully set forth in the various addresses delivered at the dedication of its Museum Building in Golden Gate Park last September, this annual report will be brief and devoted in the main to a summarization of such facts and events as seem worthy of special mention.

No special effort has been put forth during the last year to swell the Academy's membership list. The accession of new members has nevertheless a little more than offset the losses by death and resignation. The present membership in the Academy is 483, made up of:

Patrons	5
Honorary Members	26
Life Members	83
Members	369

During the year 1916 there was an accession of 33 new members, and the Academy lost by death 5, by resignation 11, and by being dropped for arrearages in dues 6; leaving a net gain in membership of 11.

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The losses by death were:

Davis, Mr. Horace.....Life Member .....July 12, 1916
Gutzkow, Mr. Frederick.....Life Member .....May 7, 1916
Leszynsky, Mr. S. L.....Member .....March 8, 1916
Sclater, Dr. Philip Lutley.....Honorary Member .....———, 1916
Trask, Mrs. Blanche .....Life Member .....Nov. 11, 1916

The Academy carries on its list of patrons the following names:

Alvord, William	Bourn, William B.
Crocker, Charles	Crocker, William H.
Hendrie, John W.	Dunne, Peter F.
Lick, James	Grant, Joseph D.
Hosmer, Mrs. Charlotte	Morrison, Alexander F.

Of these the last six are the surviving members. Two other public spirited citizens, Mr. Herbert Fleishhacker and Mr. A King Macomber, have recently very generously offered to instal large habitat groups in the Museum, whereby they will become patrons.

LECTURES

During the year 1916, 11 free lectures have been delivered at the stated meetings of the Academy, as follows:

January 19. "Bird and Animal Life of the Yosemite Region."
Tracy I. Storer, Assistant Curator of Birds, Museum of Vertebrate Zoology, University of California.

March 15. "The Gulls in and about San Francisco."
Joseph Mailliard.

April 19. "Bird Life as seen through a Camera."
Dr. J. Rollin Slonaker, Professor of Physiology, Stanford University.

May 17. "The Relation of our Salmon and Trout to Forest Conservation."
N. B. Scofield, Expert in charge of the Department of Commercial Fisheries, California State Fish and Game Commission.

June 21. "Game Conditions in Great Britain vs. Conditions in California."
Carl Westerfeld, California Fish and Game Commissioner.

July 19. "Horticultural Quarantine."
Frederick Maskew, Chief Deputy Quarantine Officer of the California State Horticultural Commission.

August 16. "A Naturalist in the Bahama Islands."
Dr. Charles Lincoln Edwards, Director of the Los Angeles Zoological Park and Aquarium.

September 20. "The Fur Seals and other animals of the Pribilof Islands."
George A. Clark, Academic Secretary of Stanford University.

October 18. "The Physiographic History of the Southern Sierra and Mojave Desert Regions."
Dr. John P. Buwalda, Instructor in Geography, University of California.

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NOVEMBER 15. "Japanese Pearl Fisheries."
Prof. C. A. Kofoid, Department of Zoology, University of California.

DECEMBER 20. "The California Pocket Gopher as a Useful Animal."
Dr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California.

In addition, Sunday afternoon lectures are being delivered in the Museum building, since October. The list for 1916 embraces the following:

OCTOBER 22. "Picturesque India."
Dr. Walter K. Fisher, Stanford University.

OCTOBER 29. "To the Tip-top of the United States in Quest of the Golden Trout."
Dr. Barton W. Evermann, Director of the Museum.

NOVEMBER 5. "A Trip to the Southern Sierra Nevada and the Cañon of the Kern."
Dr. Roy E. Dickerson, Assistant Curator of Paleontology.

NOVEMBER 12. "The Argentine Ant; a Pest from South America."
Prof. C. A. Woodworth, Department of Agriculture, University of California.

NOVEMBER 19. "Ups and Downs of the Pacific Coast."
Prof. R. S. Holway, Department of Geography, University of California.

NOVEMBER 26. "Some Common California Mammals."
Dr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California.

DECEMBER 3. "Injurious Insects."
Prof. E. A. Essig, Department of Agriculture, University of California.

DECEMBER 10. "Turtles of the Galapagos Islands."
Dr. John Van Denburgh, Curator of the Department of Herpetology, California Academy of Sciences.

ACCESSIONS TO THE MUSEUM AND LIBRARY

Among the notable donations with which the Academy's collections of material and of books have been enriched during 1916, the following may be noted:

Argentine Government, through Hon. Enrique M. Nelson, Commissioner-General, Panama-Pacific International Exposition: Thirty-nine specimens of mounted Argentine birds; eight mounted specimens of native mammals; 10 boxes of exhibits of native insects; 10 framed colored drawings of Argentine plants; one stereoscope and 37 slides; exhibit illustrating water filtration; specimens of Argentine plants.

Branner, Dr. John C., Stanford University: 55 bound volumes.

California Botanical Club, through Miss Alice Eastwood: A collection of 397 specimens of Mexican plants collected by Dr. Edward Palmer in 1910, purchased for $39.80 by the Club.

Crocker, Mr. William H.: Three large folios, "Japanese Temples and their Treasures."

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Evermann, Dr. Barton W.: Ten manganese nodules dredged by the U. S. Fish Commission Steamer Albatross in the South Pacific during the Agassiz-Albatross South Pacific Expedition of 1899-1900, and a collection of garnets from St. George Island, Pribilof Group.

Grant, Mr. J. D.: One buffalo skull from the Klamath River.

Heyer, Mrs. H. C., San Francisco: Sixty-one specimens of Alaska birds, chiefly water birds.

Kelly, Mr. James H., Tiburon, Cal.: Twenty-one numbers of the earlier publications of the Academy.

Logan, Mr. Hugh B. Baker, Ore., through Mr. John W. Mailliard: One skin of the Mountain Coyote (*Canis latrans lestes*), male, from North Powder, Baker Co., Oregon, and one skin of the Pallid Barred Wildcat (*Lynx fasciatus pallescens*), male, from Salisbury, Baker Co., Oregon, both collected by the donor.

Martin, Mr. Bruce: 627 insects collected in Colombia, South America, including some very interesting forms.

Mailliard, Mr. John W.: Two specimens of the California Condor (*Gymnogyps californianus*), collected in San Diego Co., California, by E. B. Towne.

Merriam, Dr. C. Hart, Washington, D. C.: A collection of 486 specimens of Atlantic coast mosses, comprising 65 genera and 181 species, all new to the herbarium.

Smith, Mr. L. E., Sisson, Cal.: One hundred and forty-nine bound volumes.

Snodgrass, Mr. R. E.: Seventeen volumes and 13 pamphlets, concerning the Galapagos Islands.

Tobin, Mr. J. S.: Cash donation, $250.

U. S. Fisheries Steamer "Albatross": Twenty-one bird skins; 181 jars, vials and bottles of specimens of fishes, sponges, molluscs, crustaceans, etc.

PUBLICATIONS

The Academy has published during 1916 the following papers in continuation of the Fourth Series of the Proceedings:

Vol. V, No. 7, pp. 195-201
REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1915
by C. E. Grunsky, President of the Academy.

Vol. V, No. 8, pp. 202-223
REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1915
by Barton Warren Evermann, Director of the Museum.

Vol. VI, No. 1, pp. 1-17
EOCENE OF LOWER COWLITZ RIVER VALLEY, WASHINGTON
by Charles E. Weaver.

Vol. VI, No. 2, pp. 19-40
THE POST-EOCENE FORMATIONS OF WESTERN WASHINGTON
by Charles E. Weaver.

Vol. VI, No. 3, pp. 41-52
THE OLIGOCENE OF KITSAP COUNTY, WASHINGTON
by Charles E. Weaver.

Vol. VI, No. 4, pp. 53-85
THE PACIFIC COAST RACES OF THE BEWICK WREN
by Harry S. Swarth.

Vol. VI, No. 5, pp. 87-128
MONOGRAPH OF THE NORTH AMERICAN SPECIES OF ORTHOTYLUS (HEMIPTERA)
by Edward P. Van Duzee.

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Vol. VI, No. 6, pp. 129-213
A CATALOGUE AND HOST LIST OF THE ANOPLURA
by G. F. Ferris.

Vol. VI, No. 7, pp. 215-221
FOUR SPECIES OF SALAMANDERS NEW TO THE STATE OF CALIFORNIA, WITH A DESCRIPTION OF PLETHODON ELONGATUS, A NEW SPECIES, AND NOTES ON OTHER SALAMANDERS.
by John Van Denburgh.

Title pages and Indices for Fourth Series, Proceedings, Volumes IV and V, have also been printed but have not yet been distributed.

The notable event in the affairs of the Academy which marks the beginning of a new epoch in its history, was the dedication on September 22, 1916, of the new Museum building in Golden Gate Park, with a first view by members and their friends of the habitat groups of which, at that time, 11 principal groups and a number of lesser groups had been completed. The exercises on that occasion have been made a matter of record and I desire at this time only to renew the assurance to those who have made so much accomplishment possible of the sincere appreciation by all members of the Academy of the generosity and good will which has found such happy expression in this building and its contents.

Of the 11 principal groups the three bird groups were made possible by special donations as follows:

The Farallon Bird Group, by Mr. Wm. H. Crocker.

The San Joaquin Valley Bird Group, by Mr. Jos. D. Grant.

The Desert Bird Group, by Mr. Wm. B. Bourn.

I may note in connection with the installation of habitat groups that the Academy no longer commands the services of Mr. John Rowley, under whose supervision the habitat groups have been installed. Mr. Rowley has gone to the Municipal Museum of Oakland.

I cannot refrain from commending again the results of Mr. Rowley's work. The groups which have been installed portray nature, and especially the various animals therein presented, with remarkable fidelity. The general arrangement and effect of each group is pleasing and all will bear the closest inspection.

The fact that Mr. Rowley will be active in such close proximity to San Francisco as Oakland, prompts the hope that for special work as occasion arises his services will still be available.

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The Academy has been fortunate in securing the services of Mr. E. P. Van Duzee as Curator in the Department of Entomology and as active Librarian. The proper housing of the Library and the attention which it is now receiving have added greatly to its usefulness.

In the other departments of the Academy's work there has been no material change.

What has been done in these various departments will be set forth by the several curators and it would be but repetition to dwell upon their activities in this general statement of affairs.

The Director of the Museum, Dr. Evermann, will report in some detail upon the Museum and research work which has been accomplished and of the cordial appreciation which the public is manifesting in the Academy's work.

In order to make possible what has thus far been done on and in the museum building, the Academy has had to live beyond its income for several years. It has been necessary to add to our indebtedness about $35,000. This is not a serious matter but is cited as an evidence of the efforts of your Trustees and Officers to make the collected scientific material available for examination and study at the earliest possible date.

The estimated assets of the Academy are about $1,400,000, mainly represented by the Market Street property, against which there are liabilities of about $336,000. The net annual income may be stated in round numbers at about $50,000. It is expected that of this amount about $10,000 per annum can during the next few years be held available for reducing our financial obligations.

There is not yet any prospect for the enlargement of the museum building, which would only be possible by outside aid. The space which has thus far been made available is, of course, inadequate to meet prospective requirements. All friends of the Academy should, therefore, as opportunity offers, call the attention of those who are financially able, to the good work which an ample additional endowment would make possible.

In closing, I desire to express on behalf of the officers of the Academy their appreciation of the interest manifested by the members, and desire also to extend my personal thanks to the officers and members for their cordial support and also to the employees who have so willingly made sacrifices in the interest of the Academy whenever called upon to do so.

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IX

REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1916

BY

BARTON WARREN EVERMANN

Director of the Museum

At the time of the last annual report of the Director of the Museum (February 16, 1916), the actual installation of the habitat groups of California mammals and birds was well under way.

Besides the regular employees of the Division of Exhibits, who devoted all their time to the habitat groups, three extra temporary men were employed on that work for nearly a year. By the twenty-first of September the following groups had been completed:

California Valley Elk, Black-tail Deer (summer group), Northern Mule Deer (winter group), Antelope, Desert Mountain Sheep, Mountain Lion, Black Bear, Leopard Seal, California Sea Lion, Steller's Sea Lion, Raccoon and Striped Skunk, Coyote, Farallon Islands Bird Rookery, San Joaquin Valley Spring Bird Group, and Desert Bird Group. Opportunity has been taken to reproduce in this report excellent photographic illustrations of a number of these habitat groups.

In addition to these 15 groups the California Condor Group was complete with the exception of the birds, which will be secured later. Small groups of the California Valley Quail and the Western Meadowlark were also completed.

It was felt that the time had arrived for the dedication of the Museum building and the opening of the Museum to the public. The formal dedicatory exercises were held on Friday afternoon, September 22, in the California mammal room of the Museum.

Mr. C. E. Grunsky, the President of the Academy, presided.[1] The invocation was by the Right Reverend William Ford Nichols, bishop of California. Brief addresses were

[1] A report of the opening exercises was published in *Science* for October 27, 1916, pp. 598-603.

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made by the following: Mr. William H. Crocker, President of the Board of Trustees; Mr. C. E. Grunsky, President of the Academy; Mr. Edward Rainey, for the Mayor; Mr. George Haviland Barron, Curator of the Memorial Museum, San Francisco, for the Board of Park Commissioners; Dr. David Starr Jordan, Chancellor Emeritus, Stanford University; Dr. Barton Warren Evermann, Director of the Museum.

Mr. Crocker spoke feelingly of his long connection with the Academy, as President of the Board of Trustees continuously since 1898, or 18 years. Before him his brother, Charles F. Crocker, had occupied the same position for a number of years and his father, Charles Crocker, was deeply interested in the Academy.

As president of the Board of Trustees, Mr. Crocker formally dedicated the new Museum building to the advancement of the biological and physical sciences and the educational interests of the city of San Francisco and the state of California. He then turned the building over to the Academy.

Speaking of the history and the aims and ambitions of the Academy, President Grunsky said, in part:

Organized in 1853, the California Academy of Sciences has now for 63 years been conducted along broad lines for public service. Membership in the Academy at a nominal annual fee is open to all who are interested in the study or advancement of science. Its activities are directed mainly along educational lines in providing the material and opportunity for securing information on matters pertaining to the natural sciences; and second, along lines of research and study in the various subdivisions of the natural sciences.

There are those present today who will recall, and some who were active in, the activities of the Academy while it was quartered in a building at the southwest corner of California and Dupont streets, and there are many here who have enjoyed and who have profited by the natural history museum and its accessories maintained for many years prior to the great disaster of 1906 on Market between Fourth and Fifth streets.

It would be needless to present at this time a review of the history of the Academy and of the work done by it. Those who desire will find much of interest and of value in the published records of the Academy's Proceedings.

It would be futile to give a due meed of credit to those heretofore connected with the work of the Academy whose contributions have borne fruit, and whose achievement is expressed in some measure in the Museum plant now to be brought closer to the general public. It must suffice to say that at all times in the history of the Academy there was a group of

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enthusiastic scientific workers—with changing personnel—who stood ever ready to make, and did make, the sacrifices and put forth the personal effort which made the work of the Academy worth while.

In the matter of publications, as in the case of its other activities, the Academy has had to accept the limitation upon its output made necessary by the lack of adequate funds. Much has been left undone which ought to be done. Time will not, however, permit me to take up this matter for full presentation. Let me call attention merely to one fact which will be patent to all who look carefully into the affairs of the Academy. The field in which the Academy is active is but imperfectly covered; nor can it be covered as it should be without adequate support from those of means who, in furthering the aims of the Academy, will not alone be benefiting our city and commonwealth, but will be contributing to the sum of human knowledge.

The building which has here been erected and is today being dedicated is located upon public ground. The Academy has invested in it $183,000. Yet this building, while it is an earnest of what the Academy is willing to do for the public, represents, in area occupied, only about one-third of that of the museum building which we hope some day in the near future will be completed on this site.

To accomplish the incomplete work with which we desire you to become better acquainted, the Academy has taxed its resources as far as seemed wise and has made it possible to open to the public, housed in the first unit of its museum building, certain exhibits which will forecast what it is hoped may ultimately be adequately accomplished. There should be here assembled material from the Pacific Ocean and its shores representative of all the natural sciences, more complete than can be found elsewhere. It can be done and will be done, but not without outside aid. The resources of the Academy, chiefly the result of bequests and endowments that will be referred to later, are limited and our installations and facilities for housing material always obtainable in abundance must progress slowly unless the Academy can count on the generous assistance of those who have the means.

We can not at this time announce when our building will be extended. More material for research and exhibition has already been collected than we can properly display. Some of the most striking habitat groups that should be at once installed must wait until more funds are provided and in some cases until the time has come when we can add to the building.

It has been suggested that the Academy should extend its activities by assuming the management of an aquarium. I think I speak for every member when I say that the Academy is ready to do this. But even though there are those of our citizens who may be willing to erect and equip the necessary buildings the Academy is not so circumstanced that it can provide the funds for maintenance and operation. But its staff and its organization including the services of its Director of the Museum, Dr. Evermann, an expert in matters relating to fishes and the fisheries, are ready to help and will help. San Francisco should have an aquarium filled with

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the life of the Pacific Ocean and of the streams discharging into the ocean, second to no other aquarium in the world.

The Academy has asked you to be present today at this dedication of the first unit of its museum building in order that you may become better acquainted with the Academy's aims and purposes and as a reminder to the public that the Academy is here to benefit and serve the whole community.

It is appropriate that at this time attention be called to the generous aid which the Academy has received in the past and to that which it is now receiving in its plans for an enlarged field of usefulness.

It should be remembered that the Academy is in Golden Gate Park with the consent of the people of San Francisco, who have seen fit to increase the Academy's opportunity for service by permitting the erection here of the necessary museum buildings. This consent was given in 1910 and ever since that time the plans have been under consideration and in execution which are today beginning to see fulfillment.

By bequest of James Lick forty-one years ago, the Academy became the owner of the Market Street property between Fourth and Fifth streets on which for many years a museum of natural history was maintained. This property, now in use for business purposes, is the Academy's present main source of income. The Lick bequest is now carried on the books as an asset of $802,000.

In 1881 the Academy received from Mr. Charles Crocker an endowment of $20,000, the income from which is to be used in aid of scientific research.

Mr. John W. Hendrie in 1899 bequeathed to the Academy the sum of $10,000, the income from which has been set apart for the publication of scientific papers.

The late William Alvord bequeathed to the Academy the sum of $5,000, to be used in improving and adding to its herbarium.

During the last decade, while husbanding its resources, and collecting the material which is now assembled in the building being dedicated today, the Academy affairs have necessarily received but little publicity and there has been but little opportunity for the public to become acquainted with its activities; nevertheless, the Academy has been selected by many who have collected material of scientific value as the proper institution to preserve the same and make it available for the public. Attention will be called to only a few recent donations the announcement of which is appropriate on this occasion.

Our generous public-spirited fellow citizen, William M. Fitzhugh, has, by purchase and additions thereto, preserved in its entirety the collection of Indian baskets, ornaments, implements and related material made in their lifetime by the late Professor and Mrs. T. S. C. Lowe, of Pasadena. This collection of exceptional interest and magnitude, which would otherwise have been scattered and would have lost value by piecemeal sale, is on display in the Academy Museum as a loan and merits your careful attention.

The most important gift which the Academy has recently received is that of the Henry Hemphill collection of marine, freshwater and land shells. This magnificent collection, the making of which engaged the attention of

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Mr. Hemphill during practically all the years of his long and useful life, and which contains between 60,000 and 70,000 specimens representing more than 12,000 species, has been donated to the Academy by Mrs. Charlotte Hosmer, daughter of Mr. Hemphill. The Academy feels grateful to Mrs. Hosmer for this most generous gift.

The installation of the bird-habitat groups which are today being opened to your inspection and which will contribute much to the education and enjoyment of the public has been made possible by the liberality of three other San Franciscans as follows:

Mr. Wm. H. Crocker has presented to the Academy the Farallon Islands bird group.

Mr. J. D. Grant has presented to the Academy the San Joaquin Valley bird group.

Mr. W. B. Bourn has presented to the Academy the Desert bird group.

It is their wish, as it is the wish of every one in any way connected with Academy activities, that these exhibits, and the others, now to be opened to public view, may prove instructive and inspiring and a source of lasting enjoyment to all of those who care to avail themselves of the privilege, open to all, of visiting the museum.

To these donors and to all who have contributed to the service value of the Academy, the Academy, through its President, expresses its sincere appreciation and gratitude.

The Academy welcomes such aid in the accomplishment of its aims and will ever be ready to accept and manage any trust having in view the advancement of science.

Mr. Rainey, representing the Mayor, and Mr. Barron on behalf of the Board of Park Commissioners, spoke of the great benefit which the Museum of the California Academy of Sciences will be to the people of San Francisco. The location of the Museum in Golden Gate Park, the most beautiful "people's playground" in the world, is a guarantee that it will be visited not only by our own people, but by all who come to San Francisco.

Dr. Jordan spoke of the value to general education and to science of natural-history museums. He called attention to the eminent position already attained in the field of scientific research by the California Academy of Sciences, and the prominent place the Academy is destined to fill as a scientific educational institution.

In a reminiscent way, he told of his many years' connection with the Academy, as President in 1896 and 1897, and again in 1900 to 1902, of his first visit to the Academy in 1879, and his pleasant meeting at that time with W. G. W. Harford and Dr.

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Albert Kellogg the botanist and one of the founders of the Academy.

Dr. Evermann spoke in part as follows:

In the few minutes allotted to me I shall be able to speak briefly of only one or two of the museum's activities and aims.

The California Academy of Sciences is a scientific, educational institution. As a scientific, educational institution, the Academy, through its museum, has two important functions. The first of these is that of *scientific research*. The museum must furnish men and materials and facilities for scientific investigation. Through its research collections and its field investigations, it must study and solve its share of the multitude of scientific and economic problems which the physical and biological sciences present to us, particularly those presented by the zoology, botany and geology of western America and the broad Pacific. We must do our share in studying and investigating and making known the natural resources of our country. The Academy must contribute its share to the world's contributions to human knowledge.

The second important function of the Academy is *educational*. The Academy must do what it can within its means to be of real service in an educational way, not only to the general public, but also to the public and private schools.

One of the ways in which it is endeavoring to render educational service is by installing in this museum habitat groups of California mammals and birds and other exhibits that possess real educational value and which show the natural resources of the state.

Scientific research requires money and men. Habitat groups such as we are able to show you today also cost money.

The income of the Academy is limited; it is not sufficient to enable the museum to carry on the scientific work which it should do and also build up popular educational exhibits.

We have been able to prepare the splendid exhibits which we have to show you today because of the generosity of a number of public-spirited citizens of San Francisco and by curtailing somewhat for the time being the scientific activities of the Academy. Without the help of these friends of the Academy the valuable and attractive exhibits we have now installed would have been fewer in number. Nor would there have been so many if we had not drawn upon the Academy's funds for scientific research.

We have planned for several additional large habitat groups. We even have the animals on hand for a number of them. I may mention the very interesting elephant seal, a remarkable species of large marine mammal now nearly extinct. We have the animals for the group, but need funds for installing them. We have also the animals for two or three deer groups, a gigantic tortoise group, and a large iguana group. We have planned also for 22 groups of small California mammals, a dozen small bird groups similar to the very beautiful California quail group which you will see in the bird hall, and an indefinite number of small portable habitat groups such as that of the western meadowlark, which may be seen in the

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office upstairs. These we propose to loan to the public schools should they desire them.

It is hoped that the necessary funds for these exhibits may be supplied by private donations, so that the net regular income of the Academy may be reserved chiefly for scientific research. The large groups cost from $3,000 to $4,000; the small groups about $500 each; and the portable educational groups about $100 to $250 each.

It is hoped that this opportunity to do something worth while may appeal to those who are interested in education and who have the means to help along in such excellent work. What a splendid thing it would be for San Francisco and the state if, among those present here today, there might be some so impressed with the opportunity to help in this good work that they would provide the means to enable the Academy to add a dozen or more groups to the excellent series so well begun. We have the expert taxidermists and preparators to do the work; we need only the funds to meet the expense.

In conclusion, may I be permitted to mention one other need of the museum, to which I have called attention on another occasion.

It is my ambition that there shall be in this museum a *Children's Room* —a room in which will be displayed natural history objects such as are particularly attractive to little children. There would be in this room brightly and curiously colored birds and butterflies, moths and beetles and other insects; curious animals of other groups; attractive minerals, growing plants, and aquariums with interesting and instructive animal and plant life; colored transparencies of beautiful native flowers, all selected and arranged with reference to the telling of an interesting story, of teaching a definite lesson.

And there will be in this children's room a children's reading room in which will be found a library of all the interesting and reliable nature books and helps to nature study.

And there will be in charge of this children's room a well-educated, kindly, sympathetic man or woman who knows animals and plants; who knows the specimens in the museum and the live things in the park about it; and who, above all, knows and loves children; a man or woman who can wisely direct the observation and the reading of the children so that they may correlate their reading with what they have seen in the museum or in the open, and thus increase rather than stifle their interest in, and love for, animate things, as our public schools almost invariably do. It will be arranged so that children of the different grades will come to this room at different hours, and receive the instruction and help and encouragement adapted to their respective needs.

And all this will be done and done soon, I confidently believe. It will be done because it so evidently appeals to us all as being the *right thing to do*, the right sort of education and training to give our children. It will be done, because the beauty and worth of it all, for the little children's sake, will appeal to some one who has prospered in this world; some one with a kindly heart, who loves children, and who wants to help them to become the men and women they should become; and some day that man

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or woman will come forward—I wish it might be today—and, out of his abundance, endow a *Children's Room* in this museum, and thus make it possible for the California Academy of Sciences to do this splendid work for the children of California, not only of today but for those of the years to come.

At the close of the formal dedicatory exercises a private view of the exhibits thus far installed was afforded the museum's guests, of whom nearly one thousand were present in response to the special invitation.

MUSEUM HOURS

The Museum has been open to the public every day since the formal opening, September 22, 1916. The hours for the public are from 10 A. M. to 4 P. M. on week days and from 10 A. M. to 5 P. M. on holidays, including Sundays.

VISITORS AT THE MUSEUM

Attendance at the Museum has been very satisfactory. The number of daily visitors has varied on week days from fewer than one hundred on rainy, stormy days to more than 2,200, and on Sundays from 1,600 to 10,000.

Totals by months are as follows:

September (9 days)	16,448
October	36,933
November	27,718
December	15,002
January	23,170
Total to February 1, 1917	119,271

THE MUSEUM AND THE SCHOOLS

One very gratifying feature is the interest which the public and private schools are taking in the Museum. A large number of teachers have brought their entire schools to the Museum. Whenever possible the Director has accompanied the school about the halls, explaining briefly to the children the various exhibits. When the time of the school would permit the chil-

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dren were taken into the auditorium where an illustrated talk or lesson on some one of the habitat groups or other exhibits was given them.

These efforts to help the children to understand the exhibits, to show to the teachers and pupils that the exhibits in the Museum are available as illustrative materials for their regular school work, and to make the Museum of real educational value to them, are appreciated not only by the teachers but by the children as well.

The Academy is glad to be of service to the schools in this and all other ways in its power. It is hoped that even closer affiliation may be brought about and that a definite system for school visits may be arranged in the near future.

LECTURES

The regular course of free popular lectures on scientific subjects has been maintained throughout the year. These have been given at 8 o'clock on the third Wednesday evening of each month.

Soon after the formal opening of the Museum arrangements were made for a Sunday afternoon course of lectures. These have been given in the Auditorium of the Museum and have proved very popular, the attendance at each reaching in nearly every case the full capacity of the hall. Indeed, on a number of occasions, many people were turned away.

The lectures and the subjects are fully set forth in President Grunsky's report.

Through the liberality of Messrs. Wm. H. Crocker, R. J. Taussig, and John W. Mailliard the Academy has recently secured a complete moving picture equipment, including an excellent camera. It is the intention to secure a number of reels illustrative of wild animal life, particularly of the species shown in the Museum's habitat groups.

The success of the Sunday afternoon lecture course is due in large measure to the industry and resourcefulness of Messrs. Roy E. Dickerson, W. W. Sargeant, and Edward P. Van Duzee, to whom, as a committee, all lecture matters were assigned by the Director.

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EMPLOYEES

The regular employees of the Museum during the year 1916 have been as follows:

Director and Executive Curator, Dr. Barton Warren Evermann; Curator, Department of Botany, Miss Alice Eastwood; Curator, Department of Entomology, E. P. Van Duzee; Curator, Department of Herpetology, Dr. John Van Denburgh; Assistant Curator, Joseph R. Slevin; Acting Curator, Department of Mammals, John Rowley; Curator, Department of Invertebrate Zoology, Dr. Walter K. Fisher; Chief, Department of Exhibits, John Rowley; Assistants, Arthur L. Bolton, Paul J. Fair, Joseph P. Herring, and Mrs. M. L. Pariser; Assistant Curator, Department of Invertebrate Paleontology, Dr. Roy E. Dickerson; Librarian, Dr. Joseph Grinnell; Assistant Librarian, E. P. Van Duzee; Secretary, W. W. Sargeant; Stenographer and Typewriter, Miss Susie Peers; General Office Assistant, Ignatius W. McGuire; General Museum Assistant, John I. Carlson; Janitor, James H. Chastain; Assistant, Wm. C. Lewis; Janitress, Mrs. Johanna E. Wilkens; Night Watchman, Frank W. Yale; Day Watch, Patrick J. O'Brien.

DEPARTMENT ACTIVITIES

The installation of the research collections of the respective departments having been practically completed before the beginning of the calendar year 1916, the curators and their assistants have been able to devote most of their time to field work for the securing of new material and to the care and study of the collections. The condition and activities of the various departments are set forth in detail in the reports of the respective curators and need be referred to here only briefly.

Department of Botany.—The customary enthusiasm and devoted industry have characterized the department of botany during the year. The mounting and labeling of specimens has engaged much of the time of the curator. In this work she has been materially assisted by the members of the Botanical Club, with whose help the herbarium has been put in excellent condition. Among the members of the Club who have rendered especially valuable service should be mentioned Mrs. Marian L.

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Campbell, Mrs. G. Earle Kelly, Mrs. C. L. Pitcher, Mrs. Ernest Meiere, Miss Kate L. Stoney and Miss Lena Gibbs.

Many additions to the herbarium have been made within the year, the most important being a collection of 486 specimens of mosses donated by Dr. C. Hart Merriam; 81 specimens received in exchange from the U. S. National Museum; 100 plants from the Alps presented by Mrs. Zelia Nuttall; and two collections presented by the Botanical Club.

The Curator reports that the needed data for the proper labeling of the plants collected by the Academy's Galapagos expedition have at last been supplied by the collector and it is now possible to correlate the field numbers with those used in the published report.

The Botanical Club, under the supervision of the curator continues to hold weekly meetings and to be active in promoting interest in botanical matters.

The curator has maintained throughout the year in the vestibule of the Museum an exhibit of the flowers of the Park and country. This exhibit receives much attention from Museum visitors and is proving of great educational value.

Department of Entomology.—Mr. Edward P. Van Duzee, who entered upon his duties as Curator of Entomology on June first, has been indefatigable in enlarging the collections in his department, classifying, arranging, and labeling the specimens, and, in general, in making the rich material under his care available for study. During the year he made a number of short collecting trips which resulted in the addition of many valuable specimens. The total number of accessions to the department within the year is 4859.

Certain collections of the department have been sent to specialists for identification and study. The most important of these are the Orthoptera of the Galapagos expedition, sent to Messrs. Hebard and Rehm of Chestnut Hill, Pa., and the Plusiini sent to Dr. F. Ottolengui of New York.

Considerable time has been given by the curator to the determination of specimens submitted by correspondents and others who understand that the Academy is only too glad to be of service in this way.

The curator is putting through the press a synoptic catalogue of the Hemiptera of America north of Mexico, which will prove

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one of the most voluminous and important contributions of the year to entomological literature.

Department of Exhibits.—The employees of this department were engaged during the entire year on the installation of habitat groups. As stated elsewhere in this report, 17 groups were completed by September 21. Since that date two other small groups have been partially completed. Certain other exhibits have been temporarily placed in the mammal hall. The principal of these are eight cases of commercial mollusks and crustaceans and a giant clam shell, received from the United States Bureau of Fisheries; eight cases of shells from the Hemphill collection, selected for their educational value and general interest; one case of the edible clams of the west coast of America, presented by Mr. and Mrs. T. S. Oldroyd; one case of minerals, one of fossil fishes, and one of California butterflies.

A very instructive exhibit contributed by the Standard Oil Company has been temporarily installed in the Bird hall. This exhibit, installed without expense to the Academy, is illustrative of the oil industry and attracts much attention.

All these exhibits which do not logically belong in the Mammal and Bird halls will be removed to appropriate exhibition rooms as soon as an additional wing is provided.

Department of Herpetology.—The activities of this department have continued throughout the year with their usual efficiency. Commendable progress has been made in classifying and arranging the collections on the shelves in the stack rooms. This work involves the separation, identification, rebottling, labeling, and card-cataloguing of the entire collection, a task now more than one-third done.

During the year the collection was enlarged by the addition of 1536 specimens.

Considerable field work was done by the assistant curator in Nevada, Utah and Idaho, resulting in valuable collections and a much more complete knowledge of the herpetological fauna of those states.

The collections of this department now number 33,816 specimens, and are among the most extensive in America. The hope of the curator to make the department second to none in

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America in completeness and value of material is an ambition which should receive the hearty support of the Academy.

Within the year the department has contributed four papers setting forth results of studies by the curator and assistant curator of the collections of the Academy, two of which have been published. The other two will be printed soon. Other scientific papers are in course of preparation.

Department of Invertebrate Paleontology.—Mr. F. M. Anderson, the curator of this department, was on leave during the entire year, engaged on special work for certain oil companies and the Southern Pacific Railroad. The assistant curator, Dr. Roy E. Dickerson, has shown his accustomed energy and industry in looking after the interests of his department. A large amount was accomplished in preparing, sorting, identifying, and classifying the material in various collections, and putting the general collections of the department in order.

Although the budget allotment to the department was small several field expeditions were successfully conducted,—one to the Simi hills in Ventura and Los Angeles counties, one to the Marysville Buttes, one to the vicinity of Petaluma and Freestone, and one in the area on the southern border of the Mohave Desert, where certain studies in historical geology were made in co-operation with Dr. L. F. Noble of the U. S. Geological Survey.

The assistant curator has been active and productive in original research, and has within the year contributed a number of papers to paleontological literature.

Department of Invertebrate Zoology.—In this department, which is as yet only in the formative stage, the work of the year has consisted almost exclusively in the making of collections for the department. The curator spent a portion of the month of June at Monterey Bay and vicinity collecting desirable material. In the same month some collecting was done in the vicinity of Point Conception.

In co-operation with the Department of Biology of the University of Southern California, two weeks were devoted to dredging about Santa Catalina Island.

The collections of the department have also been enriched by a valuable series of west coast Gephyrean worms and a mis-

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cellaneous lot of invertebrates from British Columbia and the coast of California secured from Mr. W. F. Thompson, a small collection of California echinoderms donated by the University of Southern California, a representative series of invertebrates collected in the vicinity of Hilo, Hawaii, by Miss Leslie Tulloch, and a small lot of echinoderms from Boundary Bay, B. C., contributed by Prof. Frank W. Weymouth.

Department of Mammalogy.—As in the previous year the acting curator and his assistants devoted their time to the installation of habitat groups. Little or no time was given to enlarging the collections.

As no catalogue of the specimens in this department had ever been prepared, a proper record book was ordered made, and the collection was catalogued by Mr. Rowley, assisted by Mr. Bolton and Mr. Fair.

The total number of entries is 2300. Very few of the specimens in this department have been accurately identified. There is urgent need of a mammalogist competent to make the identifications and who can add to the collection so that it may become a fair representation of the California mammalian fauna.

Department of Ornithology.—This department being temporarily without a curator, has done no field collecting in the past year. The only additions to the collections are a few specimens received from miscellaneous sources. Mr. L. M. Loomis has continued to make use of the Tubinares of the collection in connection with the preparation of a monograph upon that group of birds upon which he is engaged.

Library.—Mr. Edward P. Van Duzee, who entered upon his duties as assistant librarian June first, came to us with long experience in library work. He had been connected with the Grosvenor Library of Buffalo, N. Y., for 28 years, 10 years as assistant librarian and 18 years as librarian. Although Mr. Van Duzee's primary duties are those of curator of Entomology, he nevertheless devotes a portion of his time to the library. With the assistance of Mr. Ignatius W. McGuire and Mr. John I. Carlson commendable progress has been made in classifying and arranging the books on the shelves. After mature consideration it was the opinion of the assistant librarian that the Decimal classification would best meet our needs, and

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that system has been adopted. The miscellaneous books in the main library, numbering some 2650 volumes, have been properly arranged and author and subject cards written by Mr. McGuire and call numbers engrossed by Mr. Carlson on the back of each book and on each card.

The sets of periodicals and publications of learned societies have also been similarly arranged.

San Diego meeting of the Western Society of Naturalists.—As one of the societies affiliated with the Pacific Division of the American Association for the Advancement of Science, which met at San Diego August 9 to 12, 1916, the Western Society of Naturalists held its annual meeting at the same time and place. The Academy was well represented at these meetings, as many as twenty of its members appearing on the various programs for the presentation of papers. Two of the three presidential addresses were given by members of the Academy, the first by Dr. W. W. Campbell, President of the Pacific Division of the American Association for the Advancement of Science, whose subject was "What we know about Comets," the second by Dr. Barton Warren Evermann, President of the Western Society of Naturalists, his subject being "Modern Natural History Museums and their relation to Public Education."

The following members of the Museum staff were present and presented papers: Miss Alice Eastwood and Messrs. Dickerson, Evermann, Grinnell and Van Duzee.

ACCESSIONS TO THE MUSEUM

The accessions to the Museum during the year have been numerous, as set forth in the detailed list in the appendix to this report. Several important donations were received from exhibitors at the Panama-Pacific International Exposition, and many others from various and miscellaneous sources.

The Academy feels very grateful to all those who have in this way contributed to its collections.

RECOMMENDATIONS

Addition to the Museum Building.—Attention is again called to the necessity for additional room for the proper housing of

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the Academy's collections and the proper display of exhibition materials already on hand or expected in the near future.

At the request of the President of the Board of Trustees the architect has submitted tentative plans and estimates for certain additions to the Museum building, as follows:

a. Closing in the Court in such a manner as to provide one floor for exhibits; estimated cost, $35,000; or
b. Closing in the Court in such a manner as to provide two floors for exhibits; estimated cost, $50,000; or
c. A main hall for the contemplated East wing; estimated cost, $90,000.

Any one of these plans would meet the present needs of the Museum fairly well.

Taxidermists' Laboratory.—The work of the Museum has been and is seriously handicapped because there is no suitable shop or laboratory in which the taxidermists and preparators can carry on their work. An item of $1500 was provided in the budget for 1916 for such a building, but it was found that this amount would not construct a building that would meet the approval of the Park Commissioners. The matter was therefore abandoned for the time being.

By using one of the habitat group cases not yet needed for exhibits and by constructing a small shed or room on the roof, we were able to get along for the time being. This arrangement is necessarily merely temporary. A suitable, commodious shop must be provided soon if the work is not to be seriously hampered.

Exhibits.—There remain five spaces for large habitat groups, —three in the Mammal hall and two in the Bird hall. Provisional plans have been made for installing in the three cases in the Mammal hall a Humboldt Elk group, a Southern Mule Deer group, and a Fur Seal group. Some of the animals required for the fur seal group have been secured through the kind co-operation of the United States Bureau of Fisheries, and it is expected the others will be obtained next fall. Efforts to secure animals for the Humboldt elk and the Southern Mule deer groups have as yet been unsuccessful, but it is hoped they may be secured next fall.

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It is proposed to install in the two remaining large cases in the Bird hall a White Pelican group and a Game Bird group showing all the species of ducks, geese and other game birds that winter in the San Joaquin Valley. Mr. Paul J. Fair with an assistant is now at the Los Baños Gun Club in Merced County collecting the birds for this group. The birds for the White Pelican group will be gotten in the spring.

In the Mammal hall provision has been made for 22 small mammal groups to be placed at either end of the large groups. The Bird hall has spaces for 12 similar small bird groups, two of which have already been installed, leaving 10 to be supplied.

It is hoped that provision may be made for securing as rapidly as possible the mammals and birds required for these small groups, and that a number of such groups be completed within the year.

Research Collections.—Attention is again called to the necessity of giving greater encouragement to research work than has been possible during the last few years. The reputation and standing of the California Academy of Sciences as a scientific institution will always be determined by the scientific workers connected with it and the contributions they make to the literature of the physical and biological sciences. Field investigations and explorations and the building up of the Museum's collections must be encouraged and provided for; and specialists and facilities must be provided for the study of the rich collections which the Museum already possesses and those which it may secure.

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APPENDIX TO THE DIRECTOR'S REPORT

LIST OF ACCESSIONS TO THE MUSEUM AND LIBRARY, 1916

Anderson, F. M., Berkeley, Cal.: Two turtle shells from Bolivar, Colombia, S. A.; and collections of Miocene, Eocene and Cretaceous fossils from near Coalinga, Cal. Gift.

Argentine Government, through Hon. Enrique M. Nelson, Vice-Commissioner General, Panama-Pacific International Exposition: Thirty-nine specimens of mounted Argentine birds; eight mounted specimens of native mammals; 10 boxes of exhibits of native insects; 10 framed colored drawings of Argentine plants; a stereoscope and 37 slides; an exhibit illustrating water filtration; specimens of ores; 300 books and pamphlets; and 145 specimens of Argentine plants. Gift.

Babcock, John P., Victoria, B. C.: Twenty-four sheets of botanical specimens from the West Coast of Vancouver Island, B. C. Gift.

Bacon, Gaston E., San Francisco: Specimen of sand dollar from the ocean beach. Gift.

Beardsley, Miss D. C., Pacific Grove, Cal.: One specimen of the whistling swan from Monterey, Cal.

Berry, S. Stillman, Redlands, Cal.: Seven pamphlets. Gift.

Blatchley, Hon. W. S., Indianapolis, Ind.: One copy of "Rhyncophora or Weevils of North Eastern America." Gift.

Brandt, W. M., Gualala, Cal.: Two obsidian arrowheads. Gift.

Branner, Dr. John C., Stanford University: Fifty-five bound volumes. Gift.

Brasil, Prof. L., University of Caen, Caen, France: One pamphlet. Gift.

California Botanical Club, through Miss Alice Eastwood: A collection of 397 specimens of Mexican plants collected by Dr. Edward Palmer in 1910, purchased for $39.80 by the Club. Gift.

California, University of, College of Agriculture, Berkeley, Cal: Fifty-five numbers of the Bulletin of the College of Agriculture, nearly completing the Academy's set. Gift.

Carlson, John I., California Academy of Sciences: One botanical specimen, exotic. Gift.

Chastain, James, California Academy of Sciences: Specimens of obsidian and pumice from Siskiyou County, Cal. Gift.

China, Government of, through the Commissioner-General, Panama-Pacific International Exposition: Two exhibit cases. Gift.

Clemens, Chaplain Joseph C., Fort Sill, Oklahoma: A collection of about 300 specimens of frogs, lizards, toads, and snakes from China and the Philippine Islands. Gift.

Clemens, Mrs. Joseph C., Fort Sill, Oklahoma: Five botanical specimens from Oklahoma. Gift.

Coleman, Mr. R. A., San Francisco: Collections of minerals and fossils from Alaska. Gift.

Cook, Melville T., New Jersey Agricultural Experiment Station, New Brunswick, N. J.: One pamphlet. Gift.

Coombs, Mrs. A. L., San Francisco: Ten specimens of plants from the Yosemite Valley. Gift.

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Crocker, Hon. Wm. H., San Francisco: Three large folios—"Japanese Temples and Their Treasures." Gift.

Dickerson, Dr. Roy E., California Academy of Sciences: Ten collections of Martinez fossils from the Simi Hills; eight collections of fossils from the Marysville Buttes; seven collections from the vicinity of Petaluma; and specimens of foraminiferal shales from Casmalia and Lompoc, Cal. Exploration.

Dorne, Mrs. Nelly Waterhouse, San Francisco: One pamphlet. Gift.

Drake, C. J., Ohio State University, Columbus, Ohio: Representatives of five recently described Tingids (Hemiptera) from the east. Gift.

Durden, H. S., San Francisco: A map of California in which each county is represented by a piece of wood from some tree native and characteristic of the county, and a collection of fossils, mesozoic ammonoids, petrified wood from the auriferous gravels of California, and several fine specimens of California minerals. Gift.

Eastwood, Miss Alice, California Academy of Sciences: Collections of botanical specimens from Colorado as follows: Two hundred thirty-four specimens from Grand Junction, 63 from Telluride, 155 from Durango, 85 from Trinidad, and 191 from the vicinity of Denver; a collection of about 500 specimens from the Grand Canyon, Arizona; 85 specimens from Gallup, New Mexico; 20 specimens from Williams, and 12 from Seligman, Arizona; a collection including 60 species, chiefly exotics, from Santa Barbara; 160 specimens, representing 140 native species, and specimens of 45 exotics, from Ventura Co., Cal. Exploration. A folio of postcards, made by Henry Hemphill; and two salamanders from San Francisco. Gift.

English, W. A., U. S. Geological Survey, Washington, D. C.: A collection of Miocene and Pliocene fossils from west side San Joaquin Valley. Gift.

Evermann, Dr. Barton W., Director of the Museum, California Academy of Sciences: Two sheets of specimens of *Spraguea umbellata* and *Spiræa splendens* from Crater Lake, Cal.; nine specimens of plants collected in the mountains back of Nordhoff, Ventura County, Cal.; 14 specimens of Colorado plants; 27 botanical specimens from Cottonwood Springs, seven from Mecca, Cal., 24 from Newhall, Cal., and 25 from Saugus, Cal.; specimens of the Walking Fern (*Camptosorus rhizophyllus*), from Knoxville, Tenn., collected in 1893; 10 manganese nodules dredged by the U. S. Fish Commission Steamer "Albatross" in the South Pacific during the Agassiz-Albatross South Pacific Expedition of 1899-1900; a collection of garnets from St. George Island, Pribilof Group; fossil leaves, Chignik Bay, Alaska; and one snake from Firebaugh, Cal. Gift.

Field, C. F., San Diego, Cal.: Miocene or Pliocene fossils from Tia Juana Valley Oil Well. Gift.

Giffard, W. M., Honolulu, T. H.: Eleven paratypes of Hymenopters (5 species); and 126 California insects. Gift.

Gordon, W. A., Los Angeles, Cal.: Miocene fossils from vicinity of Quail Lake on Osos Creek, Cal. Gift.

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Grant, Hon. J. D., San Francisco: One buffalo skull from Klamath River. Gift.

Grinnell, Fordyce, Pasadena, Cal.: Twenty sheets and five duplicates of botanical specimens from Pasadena; 20 botanical specimens from Mt. Wilson; and 316 insects from vicinage of Los Angeles. Gift.

Grove, Mrs. Jas., Camptonville, Cal.: One lizard from Yuba Co., Cal. Gift.

Hawaii, Government of, through Commissioner-General, Panama-Pacific International Exposition: Three fishes and five eels from Diamond Head, Oahu; and one turtle from Makapu, Oahu. Gift.

Henry, J. K., Vancouver, B. C.: Nine sheets of botanical specimens from Vancouver Island. Gift.

Heyer, Mrs. H. C., San Francisco: Sixty-one specimens of Alaskan birds, chiefly water birds. Gift.

Holm, Adolph, San Francisco: Three botanical specimens. Gift.

Hubbard, Samuel, Oakland, Cal.: Fourteen specimens of a species of fish (*Cyprinodon macularius*) from Saratoga Springs, Death Valley, San Bernardino Co., Cal. Gift.

Hunt, H. H.: One salamander from La Honda, Cal. Gift.

Kelly, James H., Tiburon, Cal.: Twenty-one numbers of the earlier publications of the Academy. Gift.

Klapp, Jesse R., San Francisco: A fine adult male specimen of the Western Goshawk (*Astur atricappilus striatulus*), from Golden Gate Park. Gift.

Kusche, August, Eldridge, Cal.: One hundred and twenty-seven sheets of Arctic plants from Alaska and the Yukon; 19 specimens of birds from Alaska; six mineralogical specimens from Ketchikan; and 52 specimens of Neuroptera from Alaska. Gift.

Logan, Hugh B., Baker, Ore., through Mr. John W. Mailliard, Sr., San Francisco: One skin of the Mountain Coyote (*Canis latrans lestes*), male, from North Powder, Baker Co., Ore., Feb. 10, 1916; and one skin of the Pallid Barred Wildcat (*Lynx fasciatus pallescens*), male, from Salisbury, Baker Co., Ore., Jan. 25, 1916, both collected by Mr. Logan. Gift.

Loomis, L. M., San Francisco: One bound copy, Ridgway, Birds North and Middle America, vol. 7. Gift.

Mailliard, Hon. John W., Sr., San Francisco: Two specimens of the California Condor (*Gymnogyps californianus*), collected in San Diego County, Cal., Jan. 1 and 3, 1894, by E. B. Towne; and one bound volume, "Egyptian Birds" by Charles Whymper. Gift.

Martin, Bruce, Berkeley, Cal.: A collection of 627 insects collected in Colombia, South America, 126 of these being butterflies in papers, and the balance mostly beetles. Gift.

McAllister, Otis and Miss Ethel, San Francisco: One wasp's nest. Gift.

McGuire, Ignatius, California Academy of Sciences: Three snakes from Golden Gate Park. Gift.

Meinecke, E. P., Washington, D. C.: Five pamphlets. Gift.

Menzies, R. M., San Francisco: One beetle (*Buprestis aurulenta*) from Marin Co., Cal. Gift.

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Merriam, Dr. C. Hart, Washington, D. C.: A collection of 486 specimens of Atlantic coast mosses, comprising 65 genera and 181 species, all new to the herbarium; and a cross section of the largest tree of the California lilac, *Ceanothus thyrsiflorus*, measuring 14 inches in diameter, and two cross sections of other trees of the same species and one of *Rhamnus californica*. Gift.

Miller, Mr. Charles E.: Thirty-five sheets of botanical specimens from Santa Rosa and Santa Cruz islands. Gift.

Miller, Thomas L., San Francisco: One snake skin. Gift.

Mitchell, Henry S., San Francisco: Twelve bound volumes; two nautical charts; 36 packages of shells; four fossils from the Santa Cruz Mountains; and a sextant. Gift.

Moxley, George L.: Forty-one sheets of botanical specimens from Los Angeles, Cal. Gift.

Nelson, Mr., San Francisco: Pleistocene fossils from Nome, Alaska, one mile north of present beach, four miles east of Nome. Gift.

Oldroyd, T. C., Long Beach, Cal.: A collection of edible clams of California. Gift.

Pack, Herbert J., Salt Lake City, Utah: One vial of shrimps (*Artemia*) from Great Salt Lake. Gift.

Parker, Sir Gilbert, London: A collection of about 100 pamphlets, on the European War. Gift.

Reynolds, L. C., San Francisco: A collection of insects in alcohol, and 336 insects, mostly Hemiptera. Gift.

Rixford, Dr. Emmet, San Francisco: Specimens of *Trifolium Bolanderi* collected at type locality. Gift.

Rixford, G. P., San Francisco: Seventeen sheets of botanical specimens from Riverside. Gift.

Rosenbaum, L. S., San Francisco: A collection of 232 California insects. Gift.

Ryfkogel, S. D., San Francisco: Alaskan bow, arrows, and spear, and three wooden bowls. Gift.

Sargent, Prof. L. E., Cambridge, Mass.: A collection of 120 specimens of woody plants. Exchange.

Shirk, Joseph, Berkeley, Cal.: One horned toad (*Phrynosoma*) from Berkeley; and specimens of salamander eggs. Gift.

Slevin, Joseph R., California Academy of Sciences: Three snakes, 371 lizards and 47 toads from Pyramid Lake; one snake, nine lizards, and one frog from Carlin, and 10 snakes, two toads, and 12 frogs from Elko, Nevada; 13 snakes, 23 lizards, 137 frogs, and 15 toads from Boise; four snakes, 31 frogs, five toads, and two salamanders from Payette Lake; two snakes and 56 frogs from Gyer Hot Springs; four snakes, 42 lizards, and 46 frogs from Ft. Hall, Idaho; one snake from Portland, Oregon; two snakes, 165 lizards, from Thompson, and five salamanders and 127 frogs from Salt Lake City, Utah; one snake from Carmel, one from San Jose, one from Los Baños, five lizards from Stanford University, 17 snakes, four lizards and one toad from Golden Gate Park, and two mussel shells from the Humboldt River at Elko, Nevada. Exploration.

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Smith, L. E., Sisson, Cal.: Skull of a small mammal, collected at Hilts, Siskiyou Co., Cal.; specimens of two rare species of plants from northern California, and 149 bound volumes. Gift.

Snodgrass, R. E., Washington, D. C.: Seventeen volumes and 38 pamphlets. Gift.

South Dakota, through Mr. Chas. McCaffree, Commissioner of Immigration: Specimen of iron ore. Gift.

Stonehouse, Miss Mabel E., Sisson, Cal.: Seven botanical specimens from Hilts, Siskiyou Co., Cal. Gift.

Stoner, R. G., San Francisco: A collection of Upper Miocene fossils from Topo Canyon, Cal. Gift.

Tough, F. B., Los Angeles, Cal.: Oil sands and buff-colored clay. Gift.

Troyer, Carlos, San Francisco: Pamphlet, "Indian Music," by himself. Gift.

United States Fisheries Steamer "Albatross": Twenty-one bird skins; specimens of fishes, sponges, molluscs, crustaceans, cœlenterates, amphibians, annelids, bryozoa, echinoderms, worm tubes, worms, hydroids, algæ, shells, coral, plants, brachipods, 15 insects, eight tree frogs from Cerros Island, two tree frogs and two toads, from Sweet Water Valley, San Diego Co., Cal., and one rattlesnake from Turtle Bay, Lower California. Gift.

United States National Museum, Washington, D. C.: Eighty-one specimens of cryptogams. Exchange.

Van Denburgh, Dr. John, California Academy of Sciences: One Rough-winged Swallow (*Stelgidopteryx serripinnis*) from Edenvale, Santa Clara Co., one snake and seven salamanders from Stanford University, one snake, Sausalito, three snakes from San Jose, one snake, one toad and 12 lizards from Imperial Co., two lizards and two snakes from Merced, Cal. Exploration.

Van Duzee, Edward P., California Academy of Sciences: Sixty-five specimens of insects from Los Baños; 338 specimens from Crystal Lakes, San Mateo Co.; 113 specimens from Mt. Diablo, Contra Costa Co.; 243 specimens from Niles; 87 specimens from San Francisco, 595 specimens from Lake Co., 490 specimens from San Diego, 36 specimens from Los Angeles, 124 insects from Leona Heights, Cal. Exploration. Sixteen pamphlets. Gift.

Van Dyke, Dr. E. C., Berkeley, Cal.: Eight hundred and thirty-four insects. Gift.

Varney, Mrs. F. N., San Francisco: One Short-eared owl. Gift.

Von Geldern, Otto, San Francisco: Seventy-six insects from Louisiana. Gift.

Waring, C. A., Berkeley, Cal.: Martinez fossils from the Simi Hills, Cal. Gift.

Witham, Henry, San Francisco: Four bound volumes. Gift.

Wickes, Miss E. M.: One botanical specimen from Santa Cruz, Cal. Gift.

Wooster, John, San Francisco: One hummingbird nest. Gift.

Wrasse, E., San Francisco: Specimen of oyster-shell. Gift.

Young, Carlos, San Francisco: Copper ores and mineral cabinet. Gift.

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DEPARTMENTAL REPORTS

DEPARTMENT OF BOTANY

By Alice Eastwood, *Curator*

The new Herbarium now contains 32,281 mounted sheets, representing 10,241 species and 3223 genera of Phanerogams and the higher Cryptogams. Besides these there are also the types saved from the fire and the bundles of lupines and gilias which were loaned at the time and have since been returned, but which are not yet incorporated in the herbarium on account of lack of room. There are also the collections of mosses given by Dr. C. Hart Merriam numbering 486 specimens, and 81 specimens sent in exchange from the National Museum. A collection of Hawaiian ferns and a collection of 100 plants from the Alps donated by Mrs. Zelia Nuttall after the fire have been this year mounted and put in place and almost all have added species to the collection that were very desirable. The California Botanical Club has purchased two collections at a total expense of sixty dollars.

Duplicates have been sent to the following herbariums:

Stanford University	230
Gray Herbarium of Harvard University	353
The Arnold Arboretum	411
The U. S. National Herbarium	765

Other sets of duplicates are ready for distribution but have not yet been sent and there remains still a large collection of duplicates made chiefly by the curator to be distributed into sets when time can be taken from more pressing duties.

After ten years' delay, the collection of plants from the Galapagos Islands can now be labelled. The collector has at last sent the data necessary to enable the field numbers to be correlated with the published numbers. It is an immense job which would be impossible without the classifying into families, genera and species already done by the curator. Thousands of labels will have to be written, as there are many duplicates. Help will be absolutely necessary for that labor and it should be paid for by the Academy, for it is too laborious and uninteresting for members of the Botanical Club. It is hoped that the coming year will see this collection incorporated into the herbarium and the duplicates distributed to other herbariums so that exchanges can be secured.

Without the help of some members of the Botanical Club, the herbarium could not be in its present fine condition. Mrs. Marian L. Campbell has mounted 6,854 specimens, Mrs. G. Earle Kelly 300, while Mrs. C. L. Pitcher, Mrs. Ernest Meiere, Miss Kate L. Stoney and Miss Lena Gibbs have helped in other ways. With an allowance of one hundred dollars for help, the mounting alone would have exceeded the appropriation by more than fifty dollars if the lowest price for such work should have been paid. I have had the paid help of two school girls who could come on Saturdays and after school and they have helped me in writing labels and making an inventory of the herbarium.

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The Botanical Club holds weekly meetings. These are conducted by the curator and take the form of popular talks and excursions in the park and the country. The Club is growing constantly without advertisement of any kind and has done much to make the California Academy of Sciences a popular institution. Besides this Club, the curator also conducts once a week an evening class of the young gardeners in the park who desire a scientific knowledge of the plants they cultivate. I have had to correctly name a great many species in the park, and sometimes it is very difficult as we have not the books most needed.

The exhibition of flowers from the park and the country kept up in the vestibule of the Museum has taken some time each week, but it fills a popular want. Each species is labelled with scientific name, common name, if one exists, and the native country.

It is hoped in the coming year to have the principal genera of shrubs in the park arranged in scientific sequence around the court of the Museum with labels giving not only the names and native countries, but also the families under which they are classified. If there is room I plan also a bed of the plants mentioned in the Bible and another of the plants mentioned in Shakespeare's writings. It may not be possible to obtain all, but whatever can be secured will be of interest and may lead to the final completeness.

During a six weeks' leave of absense on a trip to Colorado, the curator made large collections which will be classified elsewhere in the report. A trip was also made to Ventura and Santa Barbara in the spring and in August a trip to Southern California to attend the Pacific Coast Branch of the American Association meeting resulted in the collection of a great many exotics in Southern California.

Merriam, Dr. C. Hart, Washington, D. C.: A collection of 486 specimens of Atlantic Coast mosses, comprising 65 genera, 181 species. Gift. Also a cross section of a large tree of *Ceanothus thyrsiflorus* measuring 14 inches in diameter, and two cross sections of other trees of same species, also one of Rhamnus californica.

U. S. National Museum, Washington, D. C.: Eighty-one specimens of Cryptogams in exchange.

The California Botanical Club has purchased a collection of 385 specimens collected in California and Oregon by A. A. Heller in 1916, also a collection of 397 specimens collected in Mexico by the late Dr. Edward Palmer.

George L. Moxley has sent on 50 from the vicinity of Los Angeles for determination.

Fordyce Grinnell, Sr., has given 52 from the Sierra Madre mountains, to be named.

Miss Anna Junkans has sent 82 from Trinity County as a gift and for determination.

G. P. Rixford has contributed 37, chiefly exotics.

Mr. Charles E. Miller: Thirty-five sheets of specimens from Santa Rosa and Santa Cruz Island, also six from near Cisco.

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Mrs. Ernest Meiere: Seven California species.
Dr. Barton W. Evermann: Ninety, chiefly from California.
Mrs. G. Earle Kelly: Thirty-four, chiefly from Monterey County.
Ida M. Blochman: One from Mariposa County.
Mrs. Arch M. Gilbert: Four from California.
Colin Eastwood Clegg: Sixteen from Scenic, Washington.
Mrs. Marian L. Campbell: One hundred sixty-five from high Sierras.
Mrs. Thos. Palache: One Torreya from Sierras.
Fred Koch: One rare anemone from California.
Arthur L. Bolton: Forty-five from parts of California and Arizona.
J. P. Babcock: Twenty-four from West Coast of Vancouver.
T. D. A. Cockerell: One hundred seventy-two, chiefly New Mexico.
J. K. Henry: Nine, Vancouver.
Dr. A. Lyle: One fern from Massachusetts.
J. Aug. Kusche: One hundred thirty from Yukon and Alaska.
Miss Julia McDonald: One hundred eighty-six from Fresno County.
William H. Suksdorf; Six duplicate types.
Argentine: One hundred forty-five.
Mrs. A. L. Coombs: One hundred thirty-six California and Oregon.
C. S. Sargent: One hundred twenty exchange from Arnold Arboretum.
Adolph Holm: Four exotics.
Miss E. M. Wikes: One.
Miss Mabel E. Stonehouse: Seven.
L. E. Smith: Two.
John Carlson: One.
The Curator: Two hundred seventy-five Grand Canyon, 587 exotics, 354 miscellaneous, 158 Ventura County, 162 Grand Junction, 117 Durango, 166 near Denver, 50 Trinidad, 50 Telluride, 33 Needles, 15 Seligman, 20 Williams, 64 Gallup.

DEPARTMENT OF HERPETOLOGY

By John Van Denburgh, *Curator*

Report of the Curator of the Department of Herpetology for the year 1916.

At the beginning of the year 1916 our collection of reptiles and amphibians numbered 32,280. There have been added during the year 1536 specimens, so that we now have 33,816.

The principal sources of the specimens received during the year have been as follows:

From California: Thirty-six snakes, 25 lizards, 10 salamanders, 4 toads, 2 frogs.
From Nevada: Fourteen snakes, 378 lizards, 48 toads, 13 frogs.
From Utah: Two snakes, 176 lizards, 5 salamanders, 127 frogs.
From Idaho: Twenty-three snakes, 64 lizards, 282 frogs, 5 toads, 2 salamanders.
From Oregon: One snake.

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From Texas: Three salamanders.
From Mexico: One snake, 8 frogs.
From Colombia, S. A.: Two turtle shells.
From the Hawaiian Islands: One turtle.
From the Philippine Islands: Eight lizards, 9 frogs.
From China: Fifty-three turtles, 9 snakes, 52 lizards, 114 frogs, 59 toads.

During the year much progress has been made in classification and arrangement of the collection on the shelves. This work involves the separation, identification, rebottling, labeling and card-cataloguing of the entire collection of nearly 34,000 specimens. This huge task is now more than one-third completed.

Considerable scientific work also has been done during the year. Two short papers have been published, and two others presented for publication, while several others are in process of preparation. Among these are one on the reptiles of Nevada and one on those of Idaho.

During the coming year, it is hoped that the permanent installation of the collection may be still further advanced and the collection much increased in size. It long has been my desire to make the Academy's collection of reptiles and amphibians the largest and most valuable in America. The field is open to the Academy and there is no good reason why it should not avail itself of the opportunity to exceed all other museums in this line of research. The collection now is very large and ranks probably third in America, being exceeded by the collections of the United States National Museum and of Harvard University, each of which is perhaps fifty years older than our own. The growth of our collection during the years since the great fire has been phenomenal, but in the last five years, owing to lessened appropriations for field work, the rate of growth has been much reduced. The number of specimens added during each of the past six years has been, in round numbers, as follows:—

1911	6100	specimens
1912	3500	"
1913	2700	"
1914	800	"
1915	800	"
1916	1500	"

This is an average for the last four years of only 1450 specimens as against an average growth of over 4000 for each of the preceding seven years. The number received during the year 1911 was over 6100 specimens, but in 1914 and 1915 this was reduced to nearly 800. This reduction in the rate of growth is due to the reduction in the amount of money available for field work. The present rate of growth is quite inadequate to secure pre-eminence for our collection. If we are to do this the rate of growth must at least be restored to its former standard, and such restoration in the rate of growth means that there must again be made available larger sums of money to be devoted to this purpose. Now that the building in the Park has been completed, I hope that this may be done.

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DEPARTMENT OF INVERTEBRATE ZOOLOGY

By Walter K. Fisher, *Curator*

Since the Department of Invertebrate Zoology is in a formative stage the work for the year has emphasized the accumulation of a collection.

Systematic collecting was conducted at three points along the California coast:

1. By the curator, at Monterey Bay and vicinity, during June.
2. By Mr. Carl Hubbs, in the region of Point Conception, during June.
3. By several members of the Department of Biology, University of Southern California, during a two-weeks' cruise of their dredging boat about Santa Catalina Island.

These have resulted in the accumulation of a considerable amount of material, which is being sorted.

In addition, the curator secured from Mr. W. F. Thompson of Stanford University a very valuable collection of west coast Gephyrean worms, as well as a miscellaneous collection of invertebrates taken in British Columbia and along the coast of California.

A small collection of Southern California echinoderms was donated by the University of Southern California.

A representative series of invertebrates was collected in the vicinity of Hilo, Hawaii, by Miss Leslie Tulloch, and after her untimely death was sent to the Academy by Miss Martha Tulloch.

Prof. Frank W. Weymouth, of Stanford University, has contributed a small lot of echinoderms and crustacea from Boundary Bay, B. C.

DEPARTMENT OF INVERTEBRATE PALEONTOLOGY

By Roy E. Dickerson, *Assistant Curator*

In accordance with your request of January, the assistant curator is pleased to report concerning the activities of the Department of Invertebrate Paleontology for the current year. With a small appropriation for field work this year, the department has been able to accomplish much very desirable exploration and investigations in three different portions of California. Laboratory studies on the Oligocene of Washington and California, the Miocene of the Mexican Gulf Coast, the Caribbean, Panama and Lower California, the Pleistocene and Pliocene of Sonoma County, the Martinez-Eocene of the Rock Creek Quadrangle in Southern California, the Eocene of Mexico have been completed or are in progress. Some exhibit material has been arranged and more is in course of preparation for exhibition in the Museum.

CARE OF COLLECTIONS

The paleontological collections are practically all numbered with locality number, and the types, cotypes and figured forms given catalogue numbers as well. The conchological collections are only partially numbered, but

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the Hemphill conchological catalogue is almost completed. Approximately one-half of the Henry Hemphill conchological collection is unpacked, numbered and placed in drawer cases or exhibition cases. But little work has been attempted on the excellent collections of rocks and minerals obtained from the Exposition.

RESEARCH

During the first three weeks of June, the assistant curator investigated the Eocene and Cretaceous in the Simi Hills, which are 30 miles northwest of Los Angeles. Lower Eocene fossils of the Los Angeles basin exhibit the same peculiar facies as the Martinez fauna of the San Francisco basin. The abundance and variety of Turritellas, the Volutidæ, the Cypræidæ, and other tropical and semi-tropical forms, in comparison with the fauna of the San Francisco basin, are evidences yielded by these collections that apparently well-marked climatic zones existed during lower Eocene time, in marked contrast with the vague and indefinite climatic conditions of the Upper Eocene, Tejon, during which semi-tropical conditions existed far north of the Equator. Palms and other tropical or semi-tropical forms of the land flora occur in Washington while semi-tropical invertebrate shells are numerous in the Cowlitz phase of Washington.

Both the Rimella simplex zone or middle Tejon, and the Siphonalia sutterensis zone of the uppermost Tejon, were recognized in the vicinity of the Simi Hills. About five miles north of Chatsworth Pass, Mr. R. G. Stoner discovered an interesting locality which yielded numerous species characteristic of the uppermost Eocene of California, the Siphonalia sutterensis zone. This zone typically occurs in the Marysville Buttes, Sacramento Valley, and also extends along the western border of the Sierra Nevada, the marine equivalent of the land-laid auriferous gravels. This is the first recognition in California of the Siphonalia sutterensis zone in the outer Coast Ranges. Presumably, in most places in the coast ranges, the uppermost Eocene was removed during the interval of emergence between the Eocene and Oligocene on the Pacific Coast. About 15 new species from the Martinez-Eocene and about 12 forms new to science were found in the Tejon Eocene in this area.

The Marysville Buttes were visited in April by the assistant curator. Eight different collections were obtained from the uppermost Eocene of this region. Ten beautiful new species were found. Knoxville cretaceous fossils were discovered for the first time in this ancient volcano of the Sacramento Valley. The uppermost Cretaceous, Chico group, was discovered in four different localities and fair collections were obtained. No Horsetown or middle Cretaceous was found in this area; presumably an interval of erosion in this region represents Horsetown time, as these deposits occur in great thicknesses 30 miles west of the site of the Marysville Buttes, or faulting has uplifted the lower Cretaceous—the Knoxville—and lowered the upper Cretaceous, the Chico, and concealed the middle or Horsetown member of this Mesozoic period.

During three weeks in July, the assistant curator, aided by Mr. John B. Kerr, collected from seven different localities in the Merced formation,

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between the ocean and Petaluma and northwest in the vicinity of Freestone. The type locality of the Merced, a Pliocene formation, is located in a cliff section 3½ miles north of Mussel rock, where about 5000 feet of sands and shales are exposed. These collections demonstrate the presence of Merced strata resting unconformably upon an old erosion surface cut in ancient Franciscan rock of probable Jurassic age. Sonoma tuff, a volcanic ash and pumice deposit, was found interbedded with Merced strata in the vicinity of Freestone and environs. This tuff occurs in very extensive deposits east of Napa, and occurs at the base of the Orindan formation near Pinole. The Orindan formation which consists of lake deposits, landlaid deposits, and interbedded volcanics is an extensive formation of the Berkeley Hills. Probably it is the equivalent of the marine Merced. This correlation is further reinforced by the discovery that the Lawlor ranch beds of Sonoma Mountain, which consist of sands, gravels and clays of an intervolcanic period rest upon andesite and Sonoma tuff. These beds have yielded *Neohipparion gidleyi* Merriam. Neo-Hipparion also occurs in the Orindan strata, and the Etchegoin of the western border of the lower San Joaquin Valley.

Three collections from an ancient lake deposit east of Petaluma were obtained. Apparently a portion of the Petaluma lake beds represents a period of time somewhat younger than any of the marine Miocene of San Pablo age, as brackish water fossils were found in two localities. These fossils are identical with forms which occur in a similar deposit in the upper portion of the San Pablo formation of the Carquinez Straits vicinity, a marine formation about 2000 feet thick. Here we have apparently a transition from marine to brackish water and finally to fresh water conditions in this Miocene basin.

In summary then:

The region lying between Tomales Bay and the top of Sonoma Mountain is a block which has been but little disturbed by folding or faulting since the Pliocene. This wave-cut block has, however, been warped so that it tilts from the sea towards Sonoma and Petaluma valleys, is uplifted near Freestone on the northwest to 1100 feet, but is only 500 feet in elevation 20 miles south on the shore of Tomales Bay.

The formations involved are in order, the Franciscan group, Petaluma lake beds of upper Miocene age, Marine Merced Pliocene, Basalts, Andesites, interbedded tuffs and sandstones of inter-volcanic period of the Sonoma Mountain region, stream terraces and marine terraces of Pleistocene age.

Marine Miocene may exist beneath Sonoma Mountain, as is indicated by oil sands and oil impregnated basalts at one locality east of Petaluma.

Sonoma tuff is interbedded with the Merced formation at Freestone.

The Merced formation is the correlative in a broad way of the Sonoma tuff, the Pinole tuff, the Orindan, and probably the upper portion of the Etchegoin-Jacalitos of the San Joaquin Valley.

The Hayward fault on the west side of Sonoma Mountain exhibits many characters which are due to recent movements which produced earthquakes during recent historic time.

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At the invitation of Dr. L. F. Noble of the U. S. Geological Survey, the assistant curator spent two weeks last December in an area on the southern border of the Mojave Desert, the north flanks of the San Gabriel Mountains. This region is in a zone of great faults. Here we find blocks of Tertiary sediments dropped in between great breaks in the earth's crust. In these sediments both marine and land forms were found imbedded. From these fossils and stratigraphy as bases, the historical geology of this region is being worked out. Some relations of the land laid deposits of the Great Basin region with the marine of the Pacific Coast and Gulf of California are being solved in this field. The nature of recent faulting and its resultant topographic forms are wonderfully exemplified in this field. The results of this work will be published in collaboration with Dr. Noble, as a Professional Paper of the U. S. Geological Survey.

PUBLICATIONS

Dr. C. E. Weaver published three papers in the Academy Proceedings during the current year:—Eocene of Lower Cowlitz River Valley, Washington; The Post-Eocene Formations of Western Washington; and The Oligocene of Kitsap County, Washington. The Stratigraphy and Fauna of the Tejon Eocene of California was published by the assistant curator in the University of California Publications. A paper entitled The Stratigraphic and Faunal Relations of the Martinez Formation to the Chico and Tejon of Southern California, by Mr. C. A. Waring and The Fauna of the San Fernando Formation of Northeastern Mexico by R. E. Dickerson and W. S. W. Kew have been accepted for publication. Papers entitled: Geology of a Portion of the McKittrick District, by Mr. G. C. Gester, Ancient Panama Canals, Climatic Zones of Martinez-Eocene Time, Climatic Conditions During the Oligocene with Descriptions of New Species from the Oligocene of Washington, by R. E. Dickerson, have been submitted to the committee on publication. A paper on the Geologic History of the Marysville Buttes is in course of preparation by the assistant curator.

EXHIBITS

The Standard Oil Company has installed an oil exhibit in the east wing of the building and is now adding to, and improving it. Two cases of fossils representative of the oil bearing rocks are installed in connection with this valuable exhibit.

A portion of the Henry Hemphill conchological collection showing variation is on exhibition in the main Museum hall. Typical shells from this collection are being arranged in the reference room.

Fossil freshwater fishes from an Eocene lake in Wyoming, a collection of rocks and minerals from Washington, and a collection of the edible clams of California are also displayed in the main hall.

DONATIONS

During the year many donations of valuable specimens have been received by the Museum, which have been added to the research collections of this department, as set forth in detail in the Director's report.

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LIBRARIAN'S REPORT

By Edward P. Van Duzee, *Assistant Librarian*

Please allow me as assistant librarian to submit the following report on the work done in this department during the past fiscal year, together with a few suggestions for the coming year.

My connection with the library began on June first, 1916. I then found that after the removal of the library to the new Academy building the books had been placed on the shelves. The periodicals, the publications of societies and the administrative and scientific reports of the Federal and of the state governments, had been segregated and arranged in proper order, but only partially collated. Some of the more important individual books had been sorted out and arranged on the shelves in the reading room and a start had been made toward classifying them after the Library of Congress system. After correspondence with neighboring libraries and consultation with yourself and the members of the Academy staff it was finally decided to follow the majority of similar institutions and adopt the Decimal Classification as the one best suited to our needs. The first work done was the classification and arrangement of the miscellaneous books in the main library. The books so treated numbered 2650 volumes. Author and subject cards for these were written by Mr. Ignatius McGuire, and Mr. John Carleson engrossed the call number upon the back of each book and on each card. The sets of periodicals and publications of learned societies have also been classified and the cards for them made and engrossed, and those in the English language and a considerable part of those in foreign languages have been collated. The catalogue cards have been alphabeted in two series, one including the author and title cards, the other the subject cards, so there is now a fairly useful catalogue of the books in the main library but including very few analyticals. Current accessions to the library are entered and acknowledged as soon as possible after their receipt. An accession register has been started but is not yet nearly complete. Mr. McGuire has made the entries in this register, which now number 5401.

The most important work in this department for the coming year will be the classification and cataloguing of the state and Federal government publications in the main library and of the books in the laboratories of the departments of Botany, Ornithology and Paleontology, the books pertaining to the other departments having been mostly attended to in connection with the work on the main library. The preparation of a card shelf-list and the completion of the accessioning are other important matters to claim attention during the coming year.

I would like to suggest the desirability of having a moderate appropriation in this department, of perhaps $100, in the next fiscal year for the purchase of Library of Congress and American Library Association analytical catalogue cards for certain important sets of serial publications, a smaller sum for the construction of a wall case in the reading room suitable for the shelving of current serials and new accessions, and not less than $200 for the binding of a few important books and serial sets. The

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binding of serial publications in a scientific library is always an important and considerable item in the fixed charges of the institution and it is rarely advisable to postpone such expenditures too long or the binding of the accumulated volumes may become a serious problem.

Department of Entomology

By Edward P. Van Duzee, *Curator*

I beg to submit the following report on the condition and work in the Department of Entomology for the current fiscal year, including a few suggestions for the ensuing year.

My appointment as curator of this department took effect on June first, 1916, and on assuming the duties of the position I found the collections of the department unorganized and unarranged, although well cared for and in excellent condition. The first work done was the fumigation of the laboratory with hydrocyanic acid gas to kill museum pests introduced into the room with the Galapagos tortoises that had been temporarily stored there. Suitable book shelving was then erected, the books pertaining to the department were brought in from the main library, and the scientific apparatus and property of the department was unpacked and made available for use.

The collection of insects was found to be in almost perfect condition with practically no infestation by museum pests. There were about 200 trays well filled with mounted specimens and about 60 trays filled with unmounted material in boxes and papers. A portion of the mounted material had been properly labelled for locality and collector, but the larger part was without such labels. It has been my first duty to get this material labelled so it can be made available for study and exhibition. Many thousands of these labels have been printed and attached to the specimens and this work is now nearing completion, so the arrangement and classification of the collection can soon be begun.

During the year 4859 specimens have been added to this department by gift or through collections made by myself, and these have all been mounted and properly labelled. Very little field work was done during the year. I spent one day at Los Baños, two at or near Mt. Diablo and three in Lake County. On the last two trips I went as the guest of Mr. W. M. Giffard, so the total expense to the department for all trips was but $6.75. I also spent two days collecting about San Diego, a few hours at Manhattan Beach, Los Angeles, and took several Sunday trips about the Bay district without expense to the department. The total accessions from these collecting trips number 1976 specimens.

During the year two collections have been sent to specialists for study. The Orthoptera of the Galapagos Expedition were sent to Messrs. Hebard and Rehm and the Plusiini to Dr. Ottolengui.

A portion of my time during the past year was devoted to the study and determination of insects for correspondents of the Academy and to the publication of a bibliographical and synonymic Catalogue of the Hemiptera

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of America north of Mexico. This catalogue will soon be issued as a volume of the semicentennial publications of the University of California.

A collection of butterflies for temporary exhibition in the Mammal Hall of the Academy was prepared soon after the formal opening of the Academy building. This collection consists of 12 trays of showy exotic species and six trays of carefully determined and labelled California species which it is hoped may be of interest to children taking nature work in the public schools and to those beginning a collection of local insects and wishing help in the determination of their captures.

Looking ahead to another year the most urgent duty of the curator of this department will be the classification and arrangement of the North American material now in the collection so it will be available for scientific research. Of scarcely less importance is the accumulation of a more complete collection of the insects of California as a basis for the ecological and taxonomic study of our insect fauna. Another matter of importance in outlining the work of the coming year is the inauguration of a system of recording the material in the collection and for this purpose a card system of species-records and a book record for current lots as received and for type material seems the most practical and useful. The preparation of a permanent exhibit, especially of the insects of our own State, should not be neglected, and later when our material has been worked over and made more available the preparation of life history groups can be undertaken to good advantage. For the preparation of these exhibits and for the mounting and labelling of the accumulated material now on hand, some provision should be made in the estimates for the coming year that will allow the employment of an assistant to the curator occasionally as circumstances may require. I might add that much of this accumulated material is of great scientific interest and is indispensable for study, but in its present condition it is entirely unavailable for such purposes and practically inaccessible, and it is important that it be mounted and suitable cases provided for its reception. Much of the work of this department in the past has been the accumulation of material, but it now seems desirable that this material be made available to our own students and to other specialists who may wish to undertake its study so the Academy may profit by their labors and acquire the types and paratypes of the new species.

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FINANCIAL STATEMENTS

REPORT OF THE TREASURER

for the fiscal year ending March 31, 1917:

April 1, 1916, Cash Balance		$ 129.38
Receipts		
Dues	$ 1,539.75	
Chas. Crocker Scientific Fund Endowment Income	1,065.74	
James Lick Endowment Income	42,890.81	
General Income Account	20,165.03	
John W. Hendrie Income	607.50	
Bills Payable	631,300.00	
W. B. Bourn Donation	1,014.02	
Jos. D. Grant Donation	832.78	
Herbert Fleishhacker Donation	1,000.00	
J. S. Tobin Donation	250.00	
W. G. Wright Fund	38.50	
California Elk Expense	125.00	
Museum Appro. No. 32 Exhibits	1,077.86	
Museum Appro. No. 6 Botany	.45	
Museum	17.75	
Publication	10.21	
Appro. No. 10 Publication	66.20	
Appro. No. 40 Library	10.00	
Appro. No. 41 Desert Bird Group	18.00	
Post Card Sales	66.74	
Sundry Accounts	9.55	
		702,105.89
Carried forward		$702,235.27

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REPORT OF THE TREASURER—*Continued*

Receipts

Brought forward,—total receipts		$702,235.27

Expenditures

Expense	$ 1,951.36	
Expense, Attorney's Fees	1,500.00	
General Salary Expense	11,710.00	
Bills Payable	634,100.00	
Insurance	1,266.35	
Interest	21,671.97	
Museum $ 108.95		
Museum, Department Appro. 11,851.12		
Museum, Depart. Appro., Salaries 10,715.76		
	22,675.83	
Desert Bird Group	340.23	
San Joaquin Valley Game Bird Group	537.02	
San Joaquin Valley Bird Group	473.08	
Library	721.36	
Publication	1,592.69	
Museum Construction	4,006.00	
California Elk Expense	72.60	
Office Furniture	93.45	
Tools and Equipment	341.45	
Post Cards Purchased	79.30	
Sundry Creditors	38.52	
Sundry Advances (Museum)	780.00	
Contingent Fund	276.25	
		$704,227.46
March 31, 1917, Balance Due Crocker National Bank		$ 1,992.19

RUDOLPH J. TAUSSIG, *Treasurer.*

Examined and found correct.
McLAREN, GOODE & Co., *Auditors.*
San Francisco, Cal., April 18, 1917.

INCOME AND OPERATING EXPENSES
from April 1, 1916, to March 31, 1917:

Income

Chas. Crocker Scientific Fund Endowment Income	$ 1,065.74	
James Lick Endowment Income	42,890.81	
General Income Account	20,165.03	
Dues	1,639.75	
		$65,761.33

Expense

Salaries	22,425.76	
Expense, General $1,063.58		
Fuel 333.11		
Electricity 176.75		
Telephone 306.00		
Postage 159.58		
Stationery and Printing 244.99		
	2,284.01	
Legal Expense	1,370.00	
Insurance	1,266.35	
Interest	21,671.97	
		49,018.09
Surplus for year 1916-17		16,743.24

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BALANCE SHEET

March 31, 1917.

Assets

Real Estate—		
Market Street Lot	$600,000.00	
Jessie Street Lot	8,083.65	
Commercial Building	516,818.66	
		$1,124,902.31
Stocks—		
45 Shares, Savings Union Bank and Trust Co.		10,000.00
Museum Construction		187,855.28
Museum—		
General Collections	52,583.61	
Exploration	12,906.50	
Tools and Equipment	11,314.44	
Wm. H. Crocker Donation—		
Farallon Islands Bird Group	2,318.73	
W. B. Bourn Donation—		
Desert Bird Group	2,659.31	
J. D. Grant Donation—		
San Joaquin Valley Bird Group	2,610.42	
Herbert Fleishhacker Donation—		
San Joaquin Valley Game Bird Group, in process of installation	885.55	
		85,278.56
Library—		
Books and Equipment	14,420.74	
Publication	10,987.89	
		25,408.63
Office Furniture		2,543.84
Sundry Advances		16.55
		$1,436,005.17

Liabilities

Endowments—		
James Lick Endowment	$804,902.31	
Chas. Crocker Scientific Fund Endowment	20,000.00	
John W. Hendrie Endowment	10,000.00	
		$ 834,902.31
John W. Hendrie Endowment Income Account		8,677.50
Alvord Bequest, Botanical		5,000.00
Herbert Fleishhacker Donation		1,000.00
W. G. Wright Fund		123.70
Bills Payable		331,275.00
Sundry Creditors		311.28
Cash—		
Overdraft with Crocker National Bank	1,992.19	
Less Cash in Safe	63.63	
		1,928.56
Surplus		252,786.82
		$1,436.005.17

AUDITORS' CERTIFICATE

We have examined the foregoing Balance Sheet, together with the books and accounts of the CALIFORNIA ACADEMY OF SCIENCES, and in our opinion it is properly drawn up so as to exhibit a true and correct view of the Academy's affairs, as shown by the books.

McLAREN, GOODE & Co.,

San Francisco, Cal., April 17, 1917. *Certified Public Accountants.*

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EXPLANATION, PLATE 3

SAN JOAQUIN VALLEY ELK

(*Cervus nannodes*)

This elk, which is restricted to California, formerly ranged in great numbers over the Sacramento and San Joaquin Valleys, and westward through the Cuyama Valley into Santa Barbara County and through Santa Clara County to the coast at Monterey.

As a result of persistent persecution the great herds became reduced almost to extermination. A small band, the last of their race, took refuge on the ranch of Messrs. Miller and Lux, cattlemen, in Kern County. By the order of Mr. Henry Miller this band was rigidly protected and permitted to increase until now it numbers more than 400 head.

Recently the California Academy of Sciences, with the co-operation of Messrs. Miller and Lux and the California Fish and Game Commission, caught and distributed about 150 of these elk to various large public reservations in California. The results are very encouraging and it is believed a number of new herds will become established.

At certain seasons these elk resort to the great tule swamps; hence the name "Tule Elk," sometimes used to distinguish this species from the larger elk which inhabits the more humid coast belt north of San Francisco.

The animals in this group were obtained in Kern County, Cal.
Group prepared under the direction of John Rowley.
Background painted by Charles Abel Corwin.
Photo by Gabriel Moulin.

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Explanation, Plate 4

COLUMBIAN BLACK-TAILED DEER

(*Odocoileus columbarius*)

This group represents a summer scene in Mendocino County, California, where the deer shown were taken. At this season the deer assume what is known as the "red coat," which is gradually shed, changing to the bluish coat. The hair then becomes grayer in color as it lengthens for the winter months. In the spring the long hairs of the winter coat are shed and again replaced by the short red coat of summer.

The horns are shed annually, usually in February and March. The entire antler drops off from the skull at the base of the horn or "burr." A new horn sprouts out from the skull and, normally, develops into the antler characteristic of the species. During the process of development the horn is covered with skin and hair, as shown on the males of this group. This hairy covering is known as the "velvet." When the horn has reached its maximum growth it gradually hardens, then the animal rubs the antlers against trees and bushes and wears away the velvet covering, leaving the horns hard and polished.

The common belief that a deer develops a new point on the antlers each year and that the number of points indicates the age of the animal is erroneous.

Group prepared under the immediate direction of John Rowley.
Background by Charles Abel Corwin.
Photo by Gabriel Moulin.

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EXPLANATION, PLATE 5.

ROCKY MOUNTAIN MULE DEER

(*Odocoileus hemionus*)

This splendid deer is of wide distribution. In California it is found in the Sierras from Kern County northward, coming to the coast in the northern counties. The animals here shown were taken in Siskiyou County in October.

This is the largest of the North American deer, the adult males in prime condition weighing nearly 400 pounds.

The name "Mule Deer" is sometimes applied to this species because of its long ears and its mule-like tail.

Group prepared under the direction of John Rowley.
Background painted by Charles Abel Corwin.
Photo by Gabriel Moulin.

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EXPLANATION, PLATE 6

ANTELOPE

(*Antilocapra americana*)

The Antelope or Pronghorn formerly ranged in immense numbers over the plains and valleys of North America west of the Mississippi River from Mexico to Canada. In California great herds were found throughout the Sacramento and San Joaquin Valleys and in other valleys to the north, east and south. As a result of persistent persecution and slaughter for their hides and meat, these animals have, in most parts of their range, been entirely exterminated. In southeastern Oregon and northwestern Nevada they are still common. In California small isolated bands are still left. In all these States they are protected by law.

The Antelope is the only member of the hollow-horned animals which annually sheds its horns. Only the outer shell or sheath, however, is shed, and not the entire horn, as in the deer and elk.

The Antelope is also unique in not possessing dew claws or accessory hoofs on the backs of the feet, as in the deer.

Group prepared under the direction of John Rowley.
The background was painted by Charles Abel Corwin.
Photo by Gabriel Moulin.

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EXPLANATION, PLATE 7

DESERT MOUNTAIN SHEEP

(*Ovis nelsoni*)

This species of mountain sheep or bighorn is found in the desert mountains of southern California and adjacent parts of Nevada, Arizona and Mexico. The animals in this group were taken in December, 1913, in the San Jacinto Mountains, Riverside County, California.

The slender horns of the females have given rise to the mistaken belief that the Ibex—an animal found only in Europe and Asia—is found in America.

The story that mountain sheep sometimes jump from high precipices and alight on their horns is entirely erroneous, and is on a par with the hoopsnake, sea serpent and other similar stories.

In the desert mountains water is usually scarce, and the mountain sheep frequently eat the barrel cactus, the pulpy interior of which contains a large percentage of water; and this no doubt enables the sheep to go for long periods without drinking.

This group was prepared under the immediate direction of John Rowley. The background was painted by Charles Abel Corwin.
Photo by Gabriel Moulin.

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Explanation, Plate 8

MOUNTAIN LION

(*Felis oregonensis*)

The Mountain Lion, in its various forms, is found from Patagonia to Canada, and from the Atlantic to the Pacific. In different parts of its range it is known by different names, as Panther, "Painter," Cougar, etc.

Although not so common as formerly, it is still plentiful in certain sections of California, especially in the northern part of the State. The animals in this group were taken in Humboldt County. The Mountain Lion is the largest of the North American cats. It is very destructive to deer and certain domestic animals, particularly colts and sheep. It has been estimated that each lion in California kills on an average one deer a week throughout the year. So destructive is it that the State pays a bounty of $20.00 each for its capture. Up to June 30, 1916, the State had paid bounties on 2,534 lions.

Although the Mountain Lion is looked upon as a very fierce animal and more or less of a menace to human beings, it is really a very wary animal, and instances of its attacking man are rare indeed. It is generally easy to tree, even with a cur dog, and chasing it with dogs is the method usually employed in its capture.

Group prepared under the direction of John Rowley.
Photo by Gabriel Moulin.

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Explanation, Plate 9

NORTHWESTERN BLACK BEAR

(*Ursus americanus altifrontalis*)

The Black Bear in its various forms ranges generally from the Atlantic to the Pacific and from northern Mexico to Alaska. The specimens in this group were taken in Humboldt County, California.

In California, as elsewhere, the Black Bear may be either black or brown. In some instances both black and brown cubs are found in the same litter, and with either a black or a brown mother. Brown bears are sometimes confused with the Grizzly, which is now believed to be extinct in California.

Black bears occasionally kill sheep and pigs, but they live chiefly on nuts, roots and berries. Grubs, worms and insects also enter largely into their menu.

As a rule the Black Bear is a wary animal and will rarely or never attack a man unless wounded or cornered.

From one to four cubs (usually one or two) are produced in a litter. The cubs are usually born in January (in California) and are helpless little creatures; their eyes, like those of puppies and kittens, are closed and do not open for some time. They have no teeth and are almost naked. Although the mother bear may weigh three or four hundred pounds, the whole litter of cubs will weigh less than a pound. The cubs shown in this group were about two months old when taken.

Group prepared under the direction of John Rowley.
Photo by Gabriel Moulin.

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Explanation, Plate 10

LEOPARD SEAL

(*Phoca richardi geronimensis*)

These interesting seals are fairly common in many places along the California coast, particularly in the bays. Unlike the fur seals which are highly polygamous, the harbor seals are monogamous. On the California coast the young are born in April and May; one pup is the rule. These seals are not migratory, nor are they as gregarious as other seals. They are comparatively silent, not making a loud roaring or barking as sea lions do. They are fond of basking in the sun, especially at low tide. On the land they are clumsy creatures. They move by pulling themselves forward by their foreflippers; in swimming the hind flippers do most of the work. The rookery here shown is at Cypress Point, near Pacific Grove, California, where the animals were obtained.

Group prepared under the direction of John Rowley.
The background was painted by Charles Bradford Hudson.
Photo by Gabriel Moulin.

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EXPLANATION, PLATE 11

CALIFORNIA SEA LION

(*Zalophus californianus*)

This sea lion occurs on the sea coast and islands of California from San Francisco southward, breeding in many places, particularly on the Santa Barbara Islands. The rookery here shown is on Santa Cruz Island.

Owing to their intelligence and small size this is the species of sea lion that is commonly trained and shown in zoological gardens and elsewhere. The males are darker in color than the females, and are sometimes called black sea lions. Another characteristic of the male of this species is the great development of the bony crest on the top of the skull.

In early days sea lions were killed by thousands on the California coast for their hides and oil, but they have now become so reduced in numbers that sealing is no longer profitable. Sea lions as well as leopard seals are now protected on the California coast both by the State and Federal Governments. Among sealers the males are called "bulls," the females "cows," and the young "pups." The breeding season is from June to August, only during which time the males are found on the rookeries; at other times they go off in bands or singly living their lonely life.

Group prepared under the direction of John Rowley.
Background painted by Worth Ryder.
Photo by Gabriel Moulin.

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EXPLANATION, PLATE 12

STELLER'S SEA LION

(*Eumetopias stelleri*)

This magnificent animal ranges from the Santa Barbara Islands northward into Bering Sea. Formerly very abundant, persistent killing for its hides and oil has reduced its numbers greatly. Within the last few years they have entirely ceased breeding on the famous Seal Rocks near the Cliff House at the Golden Gate. A few individuals still resort to these rocks, but they no longer breed there.

These animals reach a large size. The adult bull shown in the group weighed 1,810 pounds. There is a great difference in size between the sexes, the females being not more than half as large as the males.

Fishermen almost without exception claim that the sea lions are very destructive to the commercial fisheries. This is probably true at certain seasons and in some localities, but investigations have not fully sustained the charge.

The breeding season of this species on the California coast is the latter half of June. One young is produced at a birth.

The noise made by the Steller Sea Lion is a loud roar, resembling that of a real lion; this, together with the long yellowish hair of the necks of the bulls, doubtless suggested the name sea lion.

This group shows the breeding rookeries on Año Nuevo Island just south of San Francisco.

Group prepared under the immediate direction of John Rowley.
Background painted by Charles Abel Corwin.
Photo by Gabriel Moulin.

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Explanation, Plate 13

CALIFORNIA RACCOON AND STRIPED SKUNK

(Procyon psora and Mephitis occidentalis)

This Raccoon is found throughout most parts of California, it being especially abundant in the heavily timbered country along the coast.

The Coon breeds in hollow trees, in holes in the rocks, in blind ditches, and even on the ground in tule swamps.

Coons are omnivorous; they eat shellfish, frogs, fish, and corn; they sometimes enter hen houses and kill and devour chickens.

In the South the negroes are very fond of the Raccoon, regarding its flesh as a delicacy. The Raccoon ranks third in value among the fur bearers of California.

The species of skunk shown in this group occurs throughout northern California except in the warmer interior valleys from Monterey northward.

The skunk brings forth its young in holes in the ground, beneath buildings, in stone piles or in hollow logs. They feed largely on insects, but will eat flesh of any kind, including chickens.

As a fur bearer the skunk is among the most valuable in the United States. In some States skunk farming has become a profitable industry.

Group prepared under the direction of John Rowley.
Photo by Gabriel Moulin.

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Explanation, Plate 14

COYOTE

(*Canis ochropus*)

The Coyote, in its various forms, ranges throughout the United States west of the Mississippi and from Mexico to Canada. In California four species or subspecies are recognized. The one shown here occurs west of the high Sierras and south to the Mexican line. It is still only too abundant in many places. The family shown in this group was obtained in Moraga Valley near Mount Diablo, which is shown in the background.

The Coyote is very destructive to sheep, young pigs and poultry. Because of its great sagacity and nocturnal predatory habits, it has always been a great nuisance to the stock and poultry raiser. Because of this and its destructiveness to the smaller wild animals, especially birds, a bounty is paid for its capture in many counties of California.

In the colder parts of its range the Coyote develops a good coat of fur and the pelts have a fair commercial value.

Group prepared under the direction of John Rowley.
Background painted by Maurice G. Logan.
Photo by Gabriel Moulin.

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Explanation, Plate 15

FARALLON ISLANDS BIRD ROOKERY

In this group, presented to the California Academy of Sciences by Hon. Wm. H. Crocker, are shown the ten species of sea birds and the one land bird (the little rock wren) that breed on the Farallon Islands. These rocky islands are about thirty miles off the Golden Gate, from which they may be seen on any clear day. Thousands of sea birds resort to these cliffs to lay their eggs and rear their young, one of the most common species being the Western Gull, which, during the rest of the year, is very abundant about San Francisco, following the ferry boats across the bay.

Until a few years ago thousands of Murre's eggs were brought each year from these rookeries and sold in San Francisco to the bakeries and pastry shops. The islands are now a Federal reservation and the birds and their eggs are rigidly protected.

The species of birds shown in this group are the following: Tufted Puffin, Brandt's Cormorant, Baird's Cormorant, Farallon Cormorant, Pigeon Guillemot, Western Gull, California Murre, Ashy Petrel, Kæding's Petrel, Cassin's Auklet, and Rock Wren, the last being the only land bird that breeds on these islands.

Group prepared under the direction of Paul J. Fair.
Background painted by Maurice G. Logan.
Photo by Gabriel Moulin.

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EXPLANATION. PLATE 16

SAN JOAQUIN VALLEY BIRD GROUP

In the spring and early summer it is the practice of the ranchmen of the San Joaquin Valley to flood their land with water, to a depth of six to eighteen inches, to induce a ranker growth of grass for pasture. Many thousand acres are thus flooded and converted into marsh land, to which vast numbers of ducks, waders and other swamp-loving birds are attracted. During the breeding season great numbers of birds resort there to build their nests, lay their eggs, and rear their young. These breeding grounds are frequented by more than thirty species of birds. Among those shown in this group, which shows a typical breeding ground near Los Baños, Merced County, California, are the Fulvous Tree Duck, Cinnamon Teal, Shoveler, Redhead Duck, Coot, American Bittern, Least Bittern, Glossy Ibis, Avocet, Black-necked Stilt, Killdeer, Red-winged Blackbird, Yellow-headed Blackbird, Tule Wren, Little Black Tern, Forster's Tern, and the Virginia Rail. In order to show in a limited area a considerable number of species it was necessary to bunch the birds a little more closely than they actually occur in nature.

Presented to the Museum of the California Academy of Sciences by Hon. Joseph D. Grant.

This group was prepared under the immediate direction of Paul J. Fair.

The background was painted by Maurice G. Logan.

Photo by Gabriel Moulin.

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EXPLANATION, PLATE 16

SAN JOAQUIN VALLEY BIRD GROUP

In the spring and early summer it is the practice of the cattlemen of the San Joaquin Valley to flood their land with water, to a depth of six to eighteen inches, to induce a ranker growth of grass for pasture. Many thousand acres are thus flooded and converted into marsh land, to which vast numbers of ducks, waders and other swamp-loving birds are attracted. During the breeding season great numbers of birds resort there to build their nests, lay their eggs, and rear their young. These breeding grounds are frequented by more than thirty species of birds. Among those shown in this group, which shows a typical breeding ground near Los Baños, Merced County, California, are the Fulvous Tree Duck, Cinnamon Teal, Shoveler, Redhead Duck, Coot, American Bittern, Least Bittern, Glossy Ibis, Avocet, Black-necked Stilt, Killdeer, Red-winged Blackbird, Yellow-headed Blackbird, Tule Wren, Little Black Tern, Forster's Tern, and the Virginia Rail. In order to show in a limited area a considerable number of species it was necessary to bunch the birds a little more closely than they actually occur in nature.

Presented to the Museum of the California Academy of Sciences by Hon. Joseph D. Grant.

This group was prepared under the immediate direction of Paul J. Fair.

The background was painted by Maurice G. Logan.

Photo by Gabriel Moulin.

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EXPLANATION, PLATE 17

DESERT BIRD GROUP

In this group, presented to the California Academy of Sciences by Hon. Wm. B. Bourn, are shown, under natural surroundings, several species of the birds that nest in the Colorado and Mohave deserts of southern California. The particular locality represented is near Cottonwood Springs, 26 miles northeast of Mecca, Riverside County, California.

The spring rains transform the desert into a veritable flower garden, and many and varied forms of vegetation send forth an astonishing amount of beautiful bloom. Then is the nesting time of the birds, which are there in surprising numbers, some of them, as the Hooded Oriole and the Vermilion Flycatcher, rivaling the flowers in brilliancy of coloration.

The total number of species of birds nesting in this part of the Colorado desert is more than a score, and some species, as Gambel's Quail, are very abundant. The nests, however, are usually widely scattered except in the vicinity of water.

The following species of birds are shown in this group: Phainopepla, Costa's Hummingbird, Mourning Dove, White-rumped Shrike, Plumbeous Gnatcatcher, Lincoln Sparrow, Western Mockingbird, Texas Woodpecker, Desert Sparrowhawk, Vermilion Flycatcher, Bullock's Oriole, Arizona Hooded Oriole, Roadrunner, Cactus Wren, House Finch, Texas Nighthawk, Gambel's Quail, Desert Sparrow, Leconte's Thrasher, Arkansas Kingbird, Verdin and Abert's Towhee. The principal plants shown are: The Palo Verde, Spanish Bayonet, Deerhorn Cactus, Prickly Pear Cactus, Barrel Cactus, Ocatilla, and the Smoke Tree or Palo Blanco.

Group prepared under the immediate direction of Paul J. Fair.
Background painted by Charles Bradford Hudson.
Photo by Gabriel Moulin.

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PROCEEDINGS

Fourth Series

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